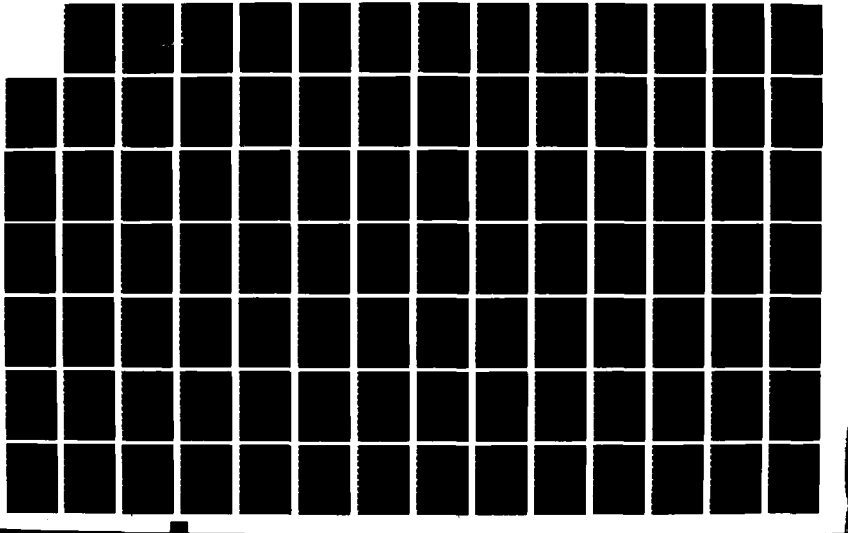
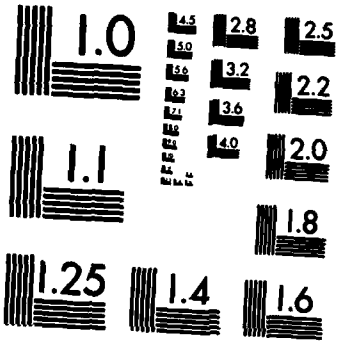
AD-A172 269 AN ANALYSIS OF THE MINERAL INDUSTRIES OF THE REPUBLICS 1/3
OFCCHINA THE PHILI (U) ARMY MILITARY PERSONNEL CENTER
ALEXANDRIA VA P C SPINLER DEC 84

UNCLASSIFIED F/G 5/3 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
An Analysis of the Mineral Industries of the Republics of China, the Philippines, and Korea, the Kingdom of Thailand, and New Zealand Vol I Chapters 1-4

5. TYPE OF REPORT & PERIOD COVERED
Masters Thesis
December 1984

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Captain Paul Charles Spinler

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Student, HQDA, MILPERCEN (DAPC-OPA-E),
200 Stovall Street
Alexandria, Virginia 22332

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
HQDA, MILPERCEN, ATTN: DAPC-OPA-E,
200 Stovall Street
Alexandria, Virginia 22332

12. REPORT DATE
December 1984

13. NUMBER OF PAGES
343 Total Count

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DTIC ELECTE SEP 19 1986 S A

18. SUPPLEMENTARY NOTES
THESIS
Energy and Minerals Resources Program
University of Texas at Austin

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Minerals, Minerals industry, Metals, Energy minerals, Industry, Republic of China, Taiwan, Republic of the Philippines, Republic of Korea, South Korea, Kingdom of Thailand, Siam, New Zealand, Western Pacific countries

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Taiwan's mineral wealth is very meager in world terms, limited in development because of the country's non-membership in world lending organizations. The Philippines has an extensive natural resource base of many strategically important minerals, but the country is extremely indebted, lacking capital to develop infrastructure and processing capacity. The Republic of Korea has not completed mineral potential surveys of the entire country. The

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

AD-A172 269

DTIC FILE COPY

Block # 20 (continued):

country's rugged terrain and undeveloped infrastructure is largely blamed for incomplete geological surveys. Thailand has significant mineral resources, but the government has no minerals policy and cannot control widespread minerals smuggling and illegal mining. This situation discourages large mineral ventures. New Zealand is also a dwarf with respect to its mineral wealth. This country has depended very heavily on farm products and is in the process of diversifying its economy. Important minerals in this part of the world include chromium, copper, cobalt, gold, tin, tantalum, natural gas, antimony, graphite, tungsten, and talc.

AN ANALYSIS OF THE MINERAL INDUSTRIES OF THE REPUBLICS OF CHINA, THE PHILIPPINES, AND KOREA, THE KINGDOM OF THAILAND, AND NEW ZEALAND

Paul C. Spinler, Captain
HQDA, MILPERCEN (DAPC-OPA-E)
200 Stovall Street
Alexandria, Virginia 22332

MASTER OF ARTS THESIS
December 1984

Approved for public release; distribution unlimited.

Submitted to
The University of Texas at Austin
Austin, Texas
in Partial Fulfillment
of the Requirements
for the Degree of
MASTER OF ARTS

86 9 18 030

COVER SHEET

(Example for completion of Cover Sheet to be attached to each thesis forwarded to Defense Technical Information Center)

(11 spaces down from top of paper)
Show title of thesis

(15 spaces down from top of paper)
Name and grade of author
HQDA, MILPERCEN (DAPC-OPA-E)
200 Stovall Street
Alexandria, VA 22332

(26 spaces down from top of paper)
Final report and date

(36 spaces down from top of paper)
Show distribution statement as shown in Block 16, of DD Form 1473

(48 spaces down from top of paper)
A thesis submitted to (Name and location of college or university)
in partial fulfillment of the requirements for the degree of (kind of degree).

Encl 2

AN ANALYSIS OF THE MINERAL INDUSTRIES OF THE REPUBLICS OF CHINA, THE PHILIPPINES, AND KOREA, THE KINGDOM OF THAILAND, AND NEW ZEALAND

VOLUME I

CHAPTERS 1-4

SEP 1 0 1990

A

DTIC COPY INSPECTED

Accession For

Dist

A-1

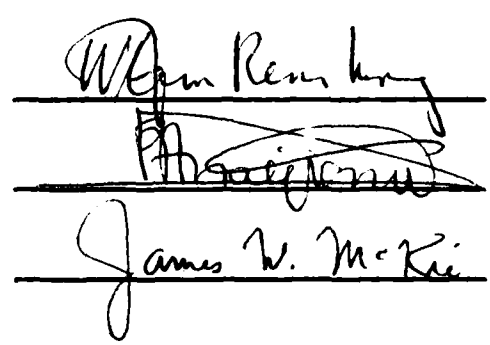
AN ANALYSIS OF THE MINERAL INDUSTRIES

OF THE

REPUBLICS OF CHINA, THE PHILIPPINES, AND KOREA,

THE KINGDOM OF THAILAND, AND NEW ZEALAND

APPROVED:



AN ANALYSIS OF THE MINERAL INDUSTRIES OF THE REPUBLICS OF CHINA, THE PHILIPPINES, AND KOREA, THE KINGDOM OF THAILAND, AND NEW ZEALAND

BY

PAUL CHARLES SPINLER, B.A., M.S.

THESIS

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF ARTS

THE UNIVERSITY OF TEXAS AT AUSTIN

December 1984

DEDICATION

This work is dedicated to my two beautiful children, Jessica Terese and Michael Paul, who make me work so hard to do my very best so I can offer them the very best. Without Jessica and Mike, my life would be incomplete. I also dedicate this volume to all of the great people I have known.

ACKNOWLEDGEMENTS

This study is indebted to the contributions of many individuals. In particular, the direction, encouragement, and persistence offered by Dr. W.C.J. van Rensburg, supervising professor, deserves foremost recognition. Additionally, suggestions and helpful criticism from Dr. Paul Anaejionu proved to be of immense value, as well as his personal interest in my private life while I was at the University of Texas at Austin. Dr. James McKie also provided valuable suggestions. These gentlemen have given generously of their valuable time despite demanding schedules.

A special thanks also goes to Edmund Chin, Taiwan and Korea Specialist, John C. Wu, Philippines Specialist, Gordon L. Kinney, Thailand Specialist, and Charles L. Kimbell, New Zealand Specialist. All of these gentlemen are dedicated physical scientists of the Division of Foreign Data, United States Bureau of Mines. Their patience and help is greatly appreciated.

The contributions given by these and other individuals including men and women from overseas governments, made this work possible. Their assistance is most greatly acknowledged.

Abstract

The United States' Pacific and Asian allies present strategic barriers between the Communist World and the Western World. Their economic stability is immensely important to their ability to maintain a strong defense and be dependable allies.

In terms of mineral wealth, each ally can be considered richly endowed in a few minerals, but poor in many others. This has greatly restricted their economic growth and industrial development. Additionally, the mineral extraction industries, though very important for export earnings, represent only very small percentages of the nations' gross national products.

The Republic of China's (Taiwan's) mineral reserves are very meager by world standards. The primary reserves in the country include coal, oil, natural gas, copper, iron sand, limestone, marble, and dolomite, but in very small quantities. Despite a lack of resources, Taiwan is one of the most competitive exporters in Asia. After being expelled from the World Bank and the International Monetary Fund, Taiwan has had to obtain capital directly from other countries and corporate joint ventures, and has had to postpone numerous major development projects due to economic slumps and a lack of capital.

The Republic of the Philippines' natural resources are ranked very highly in terms of reserves and production.

Principal mineral commodities include cobalt, copper, gold, chromium, nickel, silver, dolomite, silica, coal, and crude oil. The Philippine Government has repeatedly tried to develop its mineral industry by processing its minerals prior to export, but the country's extremely large national debt has forced lending organizations to curtail loans for the expansion of the industrial capacity in almost every sector. Presently the Philippine Government is facing serious political unrest and because of the unstable environment in the country, new mineral ventures are not likely to be negotiated in the near future.

The Republic of Korea has proven to be one of the most stable countries in the Far East, despite political turmoil and constant potential aggression from North Korea. Korea's most important mineral commodities include graphite, kaolin clay, pyrophyllite, talc, tungsten, coal, copper, gold, fluorite, iron ore, lead, silver, and zinc. The reserve base of this country has not been determined with only about one-third of the landmass completely explored for minerals. Korea faces significant problems in over-concentration of industry geographically, with nearly 95 percent of its industry located in two cities, Seoul and Pusan. Other problems include a huge defense budget and very rugged terrain inhibiting the Government's financial and physical abilities to develop the country's mineral resources.

The Kingdom of Thailand is endowed with considerable natural resources including antimony, manganese, tin, barite,

tantalum, tungsten, fluorspar, gypsum, oil, and natural gas. Thailand has displayed a remarkable ability to maintain economic growth but is totally unable to enforce mining policies and rules. Widespread illegal mining activity and smuggling has prevented the country from establishing any reserve estimates. These activities have also discouraged large mineral ventures because of the total disregard for territorial rights on mineral discoveries.

New Zealand's economy ranks high among countries in the free world with a per capita gross domestic product comparable to that of the United States. Due to an overdependence on pastoral products, the country is striving to diversify its economic base, and its mineral resources have the potential of healing the ailing economy. The most important minerals in New Zealand are natural gas, iron sand, gold, coal, crude oil, bentonite clay, silica, and limestone. The New Zealand Government is attempting to increase processing capacities to obtain more foreign exchange for its exports, but the national debt and the present ruling Labor Party make the prospects of success very bleak. The national debt is over 150 percent of annual exports, and a strong environmental organization opposes almost every new industrial project in the country.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

CHAPTER ONE:

INTRODUCTION

The Pacific and Far East are among the most important mineral-producing regions in the world, expecially when viewed in terms of mineral production versus land area. These countries are situated near a major tectonic subduction zone which has caused widespread crustal folding and crumbling and volcanism for over 150 million years, resulting in extensive metamorphism and mineralization. Sizeable shares of the world's reserves and resources of a number of strategic minerals are found in the West Pacific and Asian countries.

The Republic of the Philippines is one of the most important in terms of mineral output. Although total chromium production represents only 4 percent of world output, the Philippines was sixth in world production in 1981 and 1982, with the world's leading refractory chromite mine.[1] The country is also among the top six world cobalt producers, twentieth in world silver production, and eighth in world copper production.[2] The Philippines is also seventh with respect to gold production, processing gold as a byproduct of copper extraction.[2]

The Kingdom of Thailand is also richly endowed with minerals. The newest development in Thailand is its natural gas exploitation which has finally materialized after nine years of development. This commodity is expected to curb imports and promote economic growth, as well as generate a

series of industrial renovations. Thailand ranks fifth in antimony production and fourth in tin production, with the third largest tin reserves in the world. Columbium and tantalum production, as a byproduct of tin smelting slag, has permitted Thailand to produce 80 percent of the world's tantalum output in 1981.[3] Barite is another very important mineral in Thailand, with the country being ranked seventh in world production in the past few years.[2]

The Republic of Korea produces over 7 percent of the world's graphite, making the country fifth in terms of world output. Clay production in the country ranks eighteenth in the world, and talc and pyrophyllite is fourth among all of the world producers. South Korea is also fifth in world production of tungsten concentrate, accounting for 10 percent of annual world production.[2]

Taiwan is not a significant mineral producer and does not rank among the world's leaders in any commodity. Energy minerals are the most important, followed by dimension stone.

New Zealand is also a dwarf compared to world mineral producers. Natural gas has the potential of being a huge foreign currency earner with reserves of over 6 trillion cubic feet. Iron beach sand is the most important non-fuel mineral with millions of tons being exported to Japan each year, but still not significant in world terms.

The United States has continued to be a major trading partner with these countries, a very important stabilizing

factor in their economies. With their geographical location, these allies of the United States are extremely important avenues for maintaining Western influence in the distant Western Pacific region.

REFERENCES

1 U. S. Department of the Interior, Bureau of Mines, "Chromium," by John F. Papp, Minerals Yearbook, Vol. 1 (Washington, D. C.: U. S. Government Printing Office, 1982).

2 U. S. Department of the Interior, Bureau of Mines, Minerals Yearbook, Vol. 1 (Washington, D. C.: U. S. Government Printing Office, 1982).

3 Anon.,"Worldwide Survey," World Mining, 1972-1984.

CHAPTER TWO:

THE

MINERAL INDUSTRY

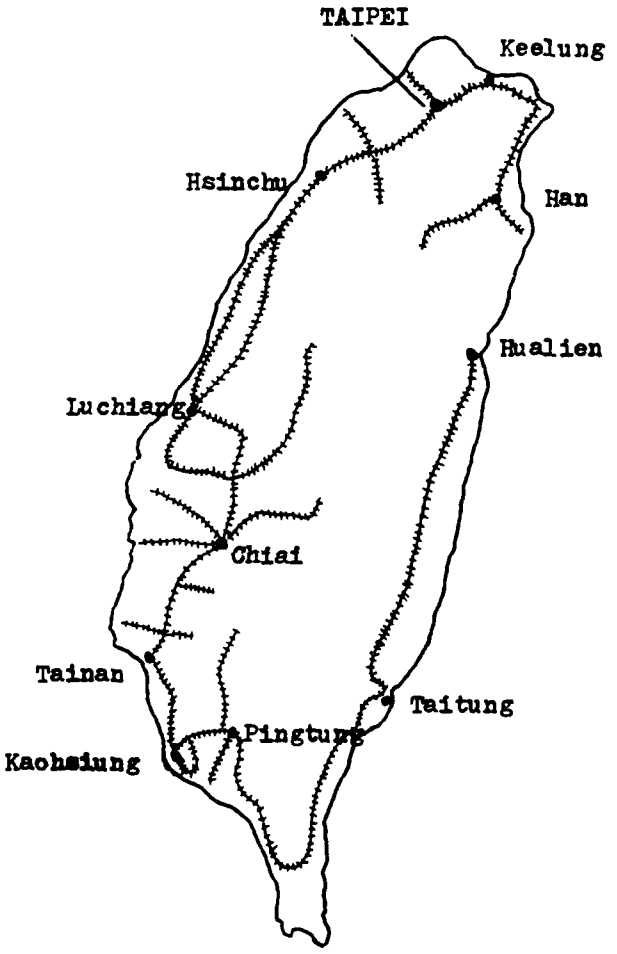
OF

THE

REPUBLIC OF CHINA

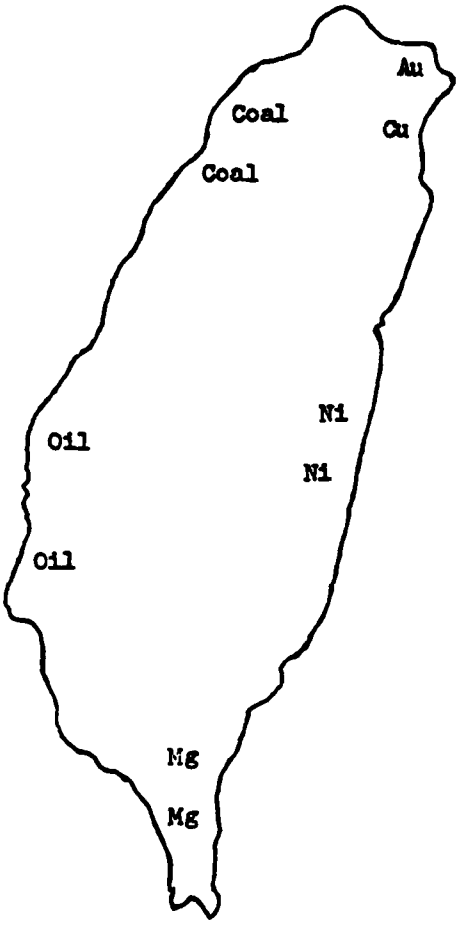
(TAIWAN)

Map 2-1. Geographic Map of the Republic of China



Source: The International Atlas, Rand McNally and Company, 1981.

Map 2-2. Mineral Distribution in the Republic of China



Scale:

0 50 100 150

Kilometers

Source: The International Atlas, Rand McNally and Company, 1981. Area Handbook of the Republic of China, Washington, D. C., 1972.

The Republic of China (Taiwan), formerly known as Formosa, was formed in 1949 when the government, in the face of Communist Chinese attacks, withdrew from mainland China to re-establish on the island of Formosa.[1] Taiwan is an island country off the coast of mainland China with an area of 35,981 square kilometers and a population of nearly 19 million people in 1983, 98 percent of which are Han Chinese, and two percent aborigines. Taipei, the capital, has nearly 2.5 million inhabitants, and other major cities include Kaohsiung, Tainan, Taichung, and Keelung.[2] The geography in Taiwan is largely mountainous with a main chain of mountains running from the north end to the south end of the island. The climate is maritime subtropical. Taiwan has a relatively high literacy rate of 89.7 percent, with education through the 9th grade compulsory, but attendance at colleges and universities is highly competitive. The system of colleges, universities, and junior colleges is extensive with over 300,000 students enrolled at any one time, with over one-third of them studying engineering or science.[2]

Over the past three decades, Taiwan has changed from an agricultural to an industrial economy. Except in 1974, during the worldwide recession caused by the Arab oil embargo, the economic growth has been rapid and sustained. Overseas investment has helped introduce modern, labor-intensive technology to the island in the 1960's, but now the emphasis is changing from production of "light industry" consumer goods for export to more sophisticated heavy industry and technology-

intensive industry.[2] The secret to Taiwan's economic success has been, and will continue to be, the emphasis given to international trade and to domestic and foreign investments.[3]

The Republic of China has modernized through five industrial development stages, beginning with rehabilitation and reconstruction after the Second World War. Then priority was given to development of import-substituting industries; textiles, foods, building materials, and transportation. The third stage emphasized export-oriented industries, giving the economy rapid growth, leading to increased needs for raw materials. The world energy situation forced Taiwan into the fifth stage in the 1980's, emphasizing high-technology and energy-efficient industries.[4]

There is a growing disparity of wealth distribution in Taiwan that dates back over 50 years. This situation stemmed from Japanese ownership of a large portion of the industrial base. As a result, many huge government corporations are now as much as 30 percent owned by the Japanese families involved. Several Chinese families, including the Chiang family, also have huge private fortunes, totalling over $1 billion each.

The mining and extractive industry's share in the Taiwanese economy has fallen from three percent in 1964 to only one percent in 1982, experiencing periods of negative growth. From an employment aspect, mining represents an insignificant percentage of the nation's 7 million people work force. Table 2-1 shows the labor distribution in Taiwan in 1980.

Table 2-1. Distribution of Labor, 1980

Sector	Percentage of Labor Force
Agriculture	28.3
Mining and Quarrying	.4
Light Manufacturing	20.6
Heavy Manufacturing	4.1
Construction	3.0
Commerce	9.2
Utilities	.3
Chemical Industry	3.3
Transportation, Storage, and Communication	6.8
Services	24.0

Source: Republic of China: A Reference Book, Republic of China Government Information Office, 1983.

GEOLOGY

The geology of Taiwan is quite varied, leading to many different types of mineral deposits, even though they are meager in size and often only marginally economical. Precious metals occur in hydrothermal and placer deposits, widely distributed on the island. Outcrops of metamorphic minerals exist and remnants of their presence can be seen frequently in river and stream channels. Limited porphyry deposits and skarn deposits are also present in Taiwan, in Miocene and Tertiary age formations. Lastly, massive sulfide deposits and irregular veins are found, associated with serpentine contacts with igneous rocks.[6]

The geological aspects of particular mineral commodities is discussed in the commodity analysis section of this chapter.

RESERVES/RESOURCES

Reserves of minerals in Taiwan are of little consequence by world standards. Coal is, by far, the most important; economically exploitable deposits located in the northwestern region are estimated to total 200 million tons. Petroleum has been found in various places, but the only producing well is at Miaoli, on the west coast. The natural gas fields occurring in the same areas are more important. Gold and copper have been mined for a number of years near Keelung, but deposits are meager and difficult to mine. Some sulfur in the form of pyrites is found, and dolomite, a source of magnesium, is found on the southwestern coast in considerable quantities. Recently, nickel deposits have been discovered on the east coast.[1] Table 2-2 shows the principal mineral reserves in Taiwan at the end of 1982.

GROSS NATIONAL PRODUCT

Taiwan's economy is progressing towards self-sufficiency. As a result of the successful export-oriented growth policy, Taiwan, like South Korea, has been able to maintain very high growth rates in the gross national product. Prior to the 1973 Arab oil embargo, Taiwan's gross national product grew more than 15 percent per year.[7] Then after 1973, Taiwan's economic expansion again flourished until most recently, in 1982, the gross national product rose only 4 percent.[8] The gross national product for 1983 has been estimated to be $48.4 billion, which was only a 3.6 percent increase from 1982.[9]

Table 2-2. Principal Mineral Reserves, 1982

Commodity	Unit	Ore Reserves	Grade
Coal	1000 MT	200,470	na
Gold	1000 MT	5,583	4-10,000 g/MT
Copper	1000 MT	12,512	.7-1 %
Pyrites	1000 MT	1,814	7-30 %
Placer Magnetite	MT	106,000	na
Limonite	MT	984,000	35 % Fe
Manganese	MT	300,000	25 % Mn
Ilmenite	MT	45,000	na
Zircon	MT	24,000	na
Monazite	MT	90,000	na
Sulfur	1000 MT	2,404	10-30 % S
Petroleum	1000 KL	1,686	na
Natural Gas	Million M^3	24,689	na
Asbestos	MT	63,100	na
Dolomite	1000 MT	116,491	18-21 % MgO
Marble	Million MT	299,925	na
Talc	1000 MT	2,277	na

Source: Taiwan Statistical Data Book, Republic of China Council for Economic Planning and Development, 1983.

With respect to its share in Taiwan's gross national product, the mineral industry has been relatively constant; for nearly 20 years, mining and quarrying has contributed between 1.0 and 2.5 percent of the GNP. Table 2-3 shows the gross national product and mining and quarrying relationships in Taiwan from 1963 to 1982. The economy of Taiwan has been affected by the decline in world markets, with foreign trade falling 7 percent in 1982.[10]

NATIONAL DEBT

The Republic of China's government expenditures have increased slowly from 21.4 percent of the gross national product in 1961 to 27.9 percent in 1982.[7] This level of spending has lead to a sizeable external national debt, but in many

respects, Taiwan has been placed in a weak position for borrowing money.

Table 2-3. Taiwan's Gross National Product (Millions of Dollars)

Year	GNP	Minerals and Mining	Percentage of GNP
1963	$1,500	$150	10.0
1964	2,000	60	3.0
1965	2,600	65	2.5
1966	3,113	47	1.5
1967	3,421	51	1.5
1968	3,809	45	1.6
1969	4,125	51	1.2
1970	4,550	69	1.5
1971	6,237	106	1.7
1972	7,173	136	1.9
1973	8,920	187	2.1
1974	13,800	381	2.7
1975	14,100	211	1.5
1976	18,100	217	1.2
1977	20,800	208	1.0
1978	24,700	222	0.9
1979	30,100	271	0.9
1980	39,570	596	1.5
1981	45,100	709	1.6
1982	46,700	479	1.0

Source: Minerals Yearbook, U. S. Bureau of Mines, Washington, D. C., 1963-1982.

In April, 1980, the International Monetary Fund voted to accept the People's Republic of China (mainland China) as a member. Automatically, Taiwan was removed from the membership, because the IMF could recognize only one Chinese government.[11] Taiwan owed the IMF over $158 million, but the IMF allowed Taiwan to purchase 470,000 troy ounces of gold at $44.80 per ounce while the current world price for gold was over $500 per ounce. This gave Taiwan $214 million worth of gold for $21 million, thus, indirectly, the IMF forgave Taiwan's debt.[11]

Later, in August of the same year, Taiwan's membership in the World Bank was terminated at the request of Peking.[12] Taiwan still owes an undisclosed amount of money to the World Bank.[12] As a result of being expelled from world lending institutions, Taiwan now seeks loans directly from the governments and banks of other countries. Presently, the external national debt is estimated to be $2,499 million to the United States, $1,332 million owed to domestic banks in Taiwan, $2,199 million owed to Japan, and $1,520 million owed to Saudi Arabia.[7]

Because of international relations with the People's Republic of China, Japanese banks have traditionally tried to keep from lending money to Taiwan, but because of Taiwan's booming economy, Japan is presently negotiating a $100 million loan with the little island country. It is believed that Taiwan's China Steel Corporation will use the money in a joint venture with Japan's Toyota Motor Corporation to build a Toyota automobile plant.[13]

The Taiwan Government has taken steps to reduce budget deficits in its efforts to curb the national debt. The 1982 deficit was $544.8 million and the 1983 deficit was $626 million.[14] The 1983 budget of $13.66 billion did not include any new projects, because they stimulate inflation, and several 1982 projects were dropped.[14] A major contributing factor to the government deficits is the large armed force supported by the Taiwan Government, using over 40 percent of the total government budget each year.[15]

ENERGY MIX

Domestic production of energy minerals in Taiwan accounts for only 15 percent of the country's total energy usage, and the Taiwan Government is taking steps to increase alternate energy supply sources to reduce the country's dependence upon imported oil. The economy in Taiwan in the 1980's has postponed the government's ability to continue its energy programs. In May 1982, the U. S. Export-Import Bank approved a $850 million loan for Taiwan Power Company, a government-owned corporation, to build two nuclear power plants, each having a capacity of 1 million kilowatts. The total cost of the project was $5 billion and included contracts with Combution Engineering Inc., Westinghouse Electric Corp., and General Electric Co., all from the United States.[16] Later in 1982, the prolonged economic slump in Taiwan forced the government to postpone plans for the 7th and 8th nuclear power plants indefinitely, which greatly upset the European and American firms who were to supply the equipment. In place of these two plants, two coal-fired 550,000 kilowatt power plants were planned, financed by the U. S. Export-Import Bank.[17]

More recently, the Taiwan Government again postponed more energy production projects because of the sluggish economy.[18] Taiwan is actually experiencing a negative growth in energy consumption; in 1982, the growth was a negative 0.9 percent.[19] The main reason for this was the slow economy and the fact that the fastest growing business sectors in Taiwan today are the low-energy-consuming industries in the electronic

and other high-technology areas. Additionally, the government has suspended several high energy-consuming industries including aluminum smelting and alkali production.[19]

The Taiwan Government is currently planning the nation's energy mix 20 years into the future, mainly through energy studies conducted by U. S. firms. By the year 2000, there will be 11 nuclear power plants, down from an original estimate of 20. Taiwan is fortunate, in this regard, because there is no organized anti-nuclear activity in the country. Hydro-electric power will not play an important role in the future because there are no future sites for dams. Natural gas is nearly depleted, for long-range planning purposes, and petroleum reserves are negligible and uncompetitive. The government is presently entering into long-term fixed contracts with suppliers of energy minerals to keep a firm, guaranteed source of supply.[19] Table 2-4 shows Taiwan's national energy mix and projections for the future.

Table 2-4. Taiwan's Energy Mix
(Percentage of Total Consumption)

Source	1961	1981	1982	1990
Coal	65	16	14	32
Oil	34	67	51	44
Natural Gas	1	5	5	1
Nuclear	0	8	8	18
Thermal	0	3	19	4
Hydro-power	0	1	3	1

Sources: Republic of China: A Reference Book, Republic of China Government Information Office, 1983.

Journal of Commerce, October 12, 1982.

Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

ENVIRONMENTAL CONSIDERATIONS

Pollution is a major problem in Taiwan. Less than one percent of investment dollars are spent for pollution reduction, and the government has recently initiated programs that put pressure on industrial firms to react to this problem.[3] The number of automobiles in Taiwan has mushroomed, and 90 percent of the vehicles do not comply with anti-pollution standards; 39 percent of the diesel-powered buses violate the standards; and 70 percent of the industries spew smoke and chemicals into the air. The biggest polluters in the industrial sector are the steel and petrochemical plants.[20] The government passed pollution control acts in 1975 for cleaner land, air, and water, and again in 1982, but it expects that another generation will pass before Taiwan will be willing to invest in major anti-pollution measures.[20] The current focus of water pollution control is on the toxic content of waste water released by factories. The "Water Pollution Control Act" was promulgated in 1974 under the Ministry of Economic Affairs, but may be shifted to the Department of Health for stricter enforcement.[4]

INFRASTRUCTURE

Taiwan's transportation system is generally considered modern and convenient, particularly since the completion of some ambitious transportation projects which have electrified Taiwan's west coast railway trunk line and linked major cities on the west coast with freeways.[4]

Railroad transportation is the backbone of Taiwan's

transit system. The total length of railways in Taiwan was 3,048 kilometers in 1981, and these lines are operated by the Taiwan Railway Administration (TRA), the state-run Taiwan Sugar Corporation, and the Taiwan Forestry Bureau. Freight and passenger services are provided to the general public by TRA, while the other two agencies only ship their own products. Due to the rapid development of highway transport, the railway system's share of freight traffic has dropped from 63 percent to 22 percent since 1971.[4] To boost railway usage, the government has electrified the west coast railway system, cutting travel time by 50 percent. This is expected to increase shipping by 7.2 percent in 1984 and 6.1 percent per year through 1989.[4]

Highway transport is the primary means of transportation in Taiwan. During the past decade, remarkable highway improvement and development has been completed, resulting in over 18,000 kilometers of roads; 73 percent are paved, 20 percent are gravel, and the remainder are unimproved dirt roads. Bus transportation is the most widely used method of travel, but from 1971 to 1980, the number of automobiles increased five-fold to over 5 million.

Taiwan's civil aviation includes two international airports and a number of domestic airports. China Airlines, flag carrier of the Republic of China, operates flights to over a dozen countries, including Japan, the United States, and South Africa.[4] Six domestic airline companies operate in Taiwan, transporting large numbers of tourists and a substantial

amount of air freight each year. Table 2-5 shows the locations of airports in Taiwan.

Table 2-5. Airports in Taiwan

Taoyuan*	Taitung	Makuag	Wangan	Taichung
Kaohsiung*	Chimei	Liuchiuy	Taipei	Tainan
Lanyu	Hualien	Chiayi	Lutao	

*International Airports

Source: Republic of China: A Reference Book, Republic of China Government Information Office, 1983.

Sea transport is of vital importance to the trade-oriented economy of Taiwan. Port traffic has been growing rapidly in the past two decades. In 1971, freight handled in Taiwan's ports was 25 million tons, but by 1981, the figure had shot up to 121 million tons. Taiwan's largest port, Kaohsiung, is one of the world's 10 leading ports. It has 4 container terminals and a tunnel underneath the harbor to transport cargo. Taiwan's second port, Keelung, in the north, is presently very conjested, and plans to expand this port are currently being reviewed, including removing a huge coral reef in the entrance of the harbor. A third major port, a manmade harbor at Taichung, is widely used, but has extremely rough water during high winds.[21] Taiwan presently has 5 international ports located at Keelung, Kaohsiung, Taichung, Hualien, and Suao.[4]

MINING, PROCESSING, AND REFINING

Minerals which are exploited in Taiwan are coal, gold, silver, copper, pyrites, petroleum, natural gas, sulfur, marble, asbestos, dolomite, graphite, mica, and salt. The production

of metals, petroleum, natural gas, and salt is under government management and ownership. The production of coal, nonmetallic mining, and quarrying is carried on predominantly by private enterprise.[1]

Taiwan's mining methods, although on a modest scale, are modern and technologically competitive with other countries. Open pit mining is the dominant method of extraction, but more exotic methods such as bacterial leaching, or microbacterial mining are also being used. Placer deposits throughout the island are mined, mainly in large open pits, and some dredging in riverbeds.[22] During the past decade, Taiwan has shifted from exporting ore and concentrate to processing and refining domestically mined minerals locally. Processing methods range from settling, flotation, and gravity segregation, to Lurgi fluid bed furnaces. Great care is taken to extract byproduct and coproduct minerals in Taiwan. Processing, refining, and mineral byproducts/coproducts are discussed later in this chapter in the mineral commodity analysis section.

INTERNATIONAL TRADE

Foreign trade has often been called the "lifeline" of Taiwan's economy, and it has been the driving force behind Taiwan's sustained and rapid economic growth. With diversified marketing outlets and a wide range of export products, Taiwan's foreign trade has been increasing at an annual rate of over 30 percent during the past three decades.[4] In 1981, total two way trade in Taiwan was over $43.8 billion, making it 19th in the

world in terms of value of foreign trade.[23] Taiwan imports items such as crude oil, machine tools, basic metals, transportation equipment, chemicals, food, beverages and tobacco, refined petroleum products, pulp and paper, plastic materials, lumber, and cereal products. Exports include textile products, wood and metal products, plastic products, fishery products, sugar, rubber, processed food, and paper products.[4]

Taiwan imports and exports with more than 150 different countries around the world, with a trade balance in Taiwan's favor for over 10 years. The largest trade surplus has been with the United States, which totalled over $6 billion in 1983.[24] The Taiwanese Government began attempting to reduce this trade surplus in 1979, but the surplus has continued to grow.[4] Major trading partners with Taiwan include Japan, the United States, Australia, European, Middle Eastern, and other Asian countries.[4]

In terms of mineral trade, crude oil has been the leading commodity import by value since 1977. Major mineral trading partners include the United States, Japan, Hong Kong, Singapore, Europe, Southern Africa, and the Middle East. For principal Mineral commodities imported and exported, and trading partners, see Tables 2-6 and 2-7, respectively.

MINERAL COMMODITY ANALYSIS

Domestic mine production of minerals in Taiwan is of little consequence by world standards. The metallic minerals mined in Taiwan include only small amounts of copper and iron.

Table 2-6. Principal Mineral Imports, 1981
(Metric Tons)

Metals	Quantity	Trading Partner(s)
Aluminum	220,370	United States
		Malaysia
Chromium	2,518	Republic of South Africa
Copper	325,971	Philippines
		Canada
		Chile
Gold (Troy Ounces)	1,166,652	Switzerland
		United States
		Japan
Iron and Steel	4,004,355	United States
		Japan
Lead	49,255	United States
		Kuwait
Manganese	64,171	Gabon
Rare Earth Metals (Kilograms)	9,686	West Germany
Nickel	2,746	Canada
Tin	16,202	Japan
		Australia
Zinc	77,923	Australia
		Japan
		Canada

Non-Metals	Quantity	Trading Partner(s)
Asbestos	30,121	Canada
		Republic of South Africa
Cement	14,078	United States
Clays	210,313	United States
		Hong Kong
		Japan
Feldspar/Fluorspar	49,606	Republic of Korea
		Japan
		Thailand
Fertilizer	385,053	United States
		Canada
Graphite	10,440	Republic of Korea
Gypsum	360,966	Japan
		Australia
		Republic of Korea
Salt	481,271	Australia
Sulfur	383,235	Canada

Mineral Fuels	Quantity	Trading Partner(s)
Coal	5,187,000	United States
Petroleum (Barrels)	145,043,000	Middle East
		United States

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

Table 2-7. Principal Mineral Exports, 1981
(Metric Tons)

Metals	Quantity	Trading Partner(s)
Aluminum	8,008	Hong Kong
		Indonesia
Copper	5,767	Japan
Iron and Steel	1,336,850	United States
		Hong Kong
		Republic of South Africa
		Republic of Korea
		Singapore
		Japan
Gold (Troy Ounces)	607,000	Philippines
Lead	14,361	Republic of Korea
		Thailand
		Japan
Silver (Troy Ounces)	1,173,395	Japan
		Hong Kong
		Malaysia

Non-Metals	Quantity	Trading Partner(s)
Clays	36,029	Hong Kong
		Singapore
		Republic of South Africa
Diamonds (1000 Carats)	71,000	Spain
		Japan
Fertilizer	6,720	Republic of Korea
Precious Stones (Kilograms)	52,787	United States
Stone, Sand, and Gravel	699,685	Japan
		Republic of South Africa

Mineral Fuels	Quantity	Trading Partner(s)
Refined Petroleum (Barrels)	9,706,000	Other Asian Countries

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

The overall value of production by the mining industry in 1982 was distributed as follows, in millions: crude petroleum and natural gas, $244; coal, $170; metals, $126; and nonmetals, $66. All of the metal mining and production of crude petroleum and natural gas was from government-owned operations. The private sector accounts for about 98 percent of coal production and 85 percent of mining and quarrying.[25] The bulk of Taiwan's industrial output of mineral-derived products is from imported materials, finished primarily for export. Table 2-8 shows at a glance the import dependence of Taiwan for many of the most common minerals.

ENERGY MINERALS

PETROLEUM

Taiwan produces only small quantities of domestic crude oil, amounting to less than two percent of the total crude oil requirements in the country.[8] The Chinese Petroleum Corporation (CPC), a government-owned enterprise, produces, imports, and markets all petroleum products used in Taiwan. This corporation owns eight ships, having the capability of handling 70 percent of the crude oil Taiwan imports. The CPC operates two refineries at Kaohsiung having a combined capacity of 434,500 barrels per day. Construction of a third refinery at Taoyuan, with a capacity of 100,000 barrels per day is scheduled to be completed in 1984. CPC also operates two petrochemical complexes; one at Kaohsiung, which uses petroleum, and the

Table 2-8. Commodity Imports, Production, Exports, and Import Dependence (Units are in Metric Tons Unless Otherwise Specified).

Commodity	Imports	Production	Exports	Import Dependence
Aluminum	220,370	49,532	8,008	100
Chromium	2,518	0	0	100
Cobalt	25	0	0	100
Copper	325,971	72,230	5,767	100
Gold (Troy Ounces)	1,166,971	56,693	607,000	43
Iron and Steel	4,004,355	4,793,585	1,336,850	65
Lead	49,255	24,000	14,361	78
Magnesium	267	0	530	100
Manganese	64,171	0	0	100
Nickel	2,746	0	1,028	100
Silver (Troy Ounces)	798,762	214,875	1,173,395	58
Tin	16,202	0	178	100
Titanium	14,627	0	107	100
Tungsten	35	0	6	100
Zinc	77,923	0	2,625	100
Asbestos	30,121	2,317	37	92
Cement	14,078	14,342,000	1,568,000	0
Clays	210,313	125,715	36,029	77
Feldspar/Fluorspar	49,606	17,215	20	65
Fertilizer	385,053	406,097	6,720	48
Gypsum	360,766	6,039	1,049	100
Salt	481,271	351,000	3,065	57
Sulfur	383,235	9,860	2,061	100
Talc	4,694	24,774	1,706	15
Coal	5,187,000	2,446,000	30	68
Petroleum (Barrels)	145,043,000	123,591,000	9,706,000	90

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

other at Toufen, which uses natural gas. These two complexes produce naptha and ethylene.[26] CPC is conducting extensive seismic and magnetic surveys for offshore oil and gas. In the past 10 years, over 70 wells have been drilled, but only 13 were economically exploitable. In 1982, 17 wells were drilled onshore, 7 were dry and 3 produced gas. In 1983 and 1984, CPC planned to continue exploration and conduct 5 drillings off the north coasts.[25]

Figure 2-1 shows annual production, imports, and exports of petroleum in Taiwan. The production curve includes refinery production from imported crude oil.

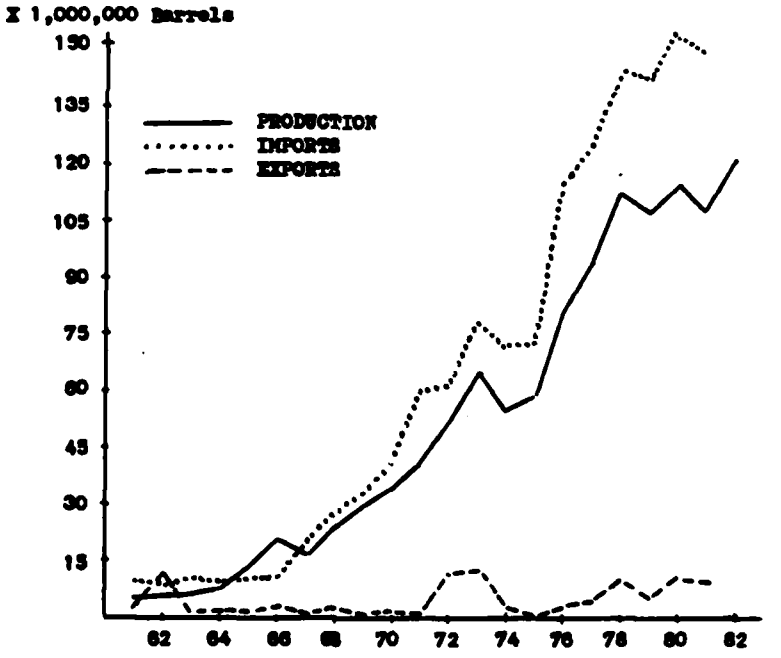


Figure 2-1: Annual Production, Imports, and Exports of Petroleum in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

NATURAL GAS

Taiwan produces sufficient quantities of natural gas to meet demands. The important gas-producing fields are the Chingtsachu, Chin Shui, Chining, Chutung, Niushan, Pashatun, Tiehchenshan, and Yunghoshan, all in the north central part of the island and offshore.[8] In 1979, natural gas reserves were estimated to be 29 billion cubic meters.[26] Figure 2-2 shows the annual production of natural gas in Taiwan. While production is small by world standards, the reserves and production of natural gas are considered an important supplement to meet current consumption levels of energy in Taiwan.

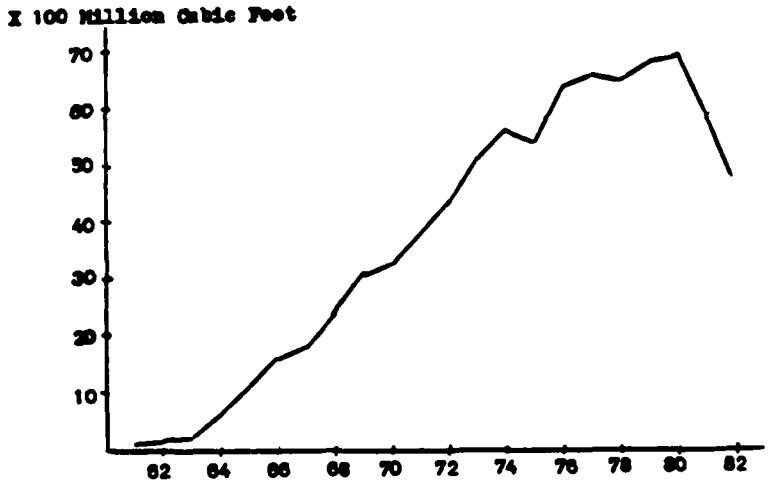


Figure 2-2: Annual Production of Natural Gas in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

COAL

Coal occurs mainly in northern Taiwan, and is the most important mineral commodity in the country. It is difficult to mine because of its location in hilly, rough terrain, and

varies greatly in thickness in the same seams.[6] Coal mining in Taiwan is a labor-intensive industry because it cannot be fully mechanized due to the thickness and irregularity of the seams. Mine production has been declining since 1970 because most of the industry has been using oil as a primary energy source. After the second world oil crisis in 1979 and 1980, the government began to push for increased coal production to lower the country's import-dependence on oil, but production has not increased due to a lack of experienced miners.[27] Production of coal is from two government-owned pits producing 2 percent of the output and 169 privately owned pits producing the rest. About 20 percent of all coal produced is classified as coking coal.[25]

Taiwan presently imports a substantial amount of coal, all from the United States, mainly to balance the two way trade between the two countries. These imports have increased very rapidly since 1976 because the government wants to establish and maintain a strategic stockpile of at least 1.5 million metric tons.[18] Figure 2-3 shows annual production and imports of coal in Taiwan. The significant decrease in production in 1978 was due to a planned reconstruction of the north-south railroad system, causing transportation disruptions that year.[27]

METALLIC MINERALS

CHROMIUM

Taiwan is 100 percent import-dependent for chromium supplies, importing them as ore, concentrate, and oxides.

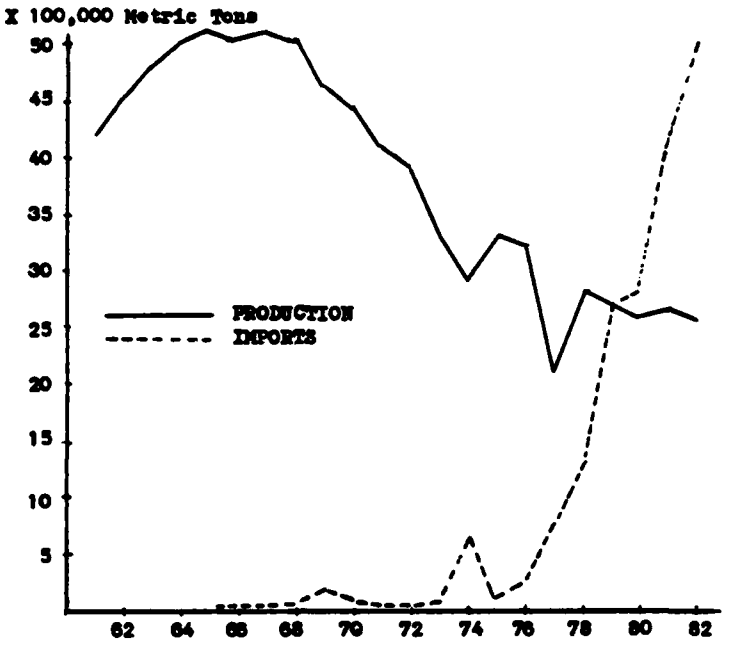


Figure 2-3: Annual Production and Imports of Coal in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Figure 2-4 shows import patterns of chromium in the Republic of China. Although demand has been somewhat unpredictable, it is expected to continue to rise in support of Taiwan's steel and automobile industries, and the stainless steel plants that opened in mid-1983.[25]

IRON AND STEEL

Taiwan has no important iron deposits. Most of the deposits in the country are beach placer deposits, with ilmenite as the primary mineral. In the north, magnetite is the dominant placer mineral, and 70-85 percent of Taiwan's iron ore reserves are in this area. Domestic mine output of iron ore is insignificant and sporatic, and, as a result, virtually all of Taiwan's requirement for iron ore is met by imports.

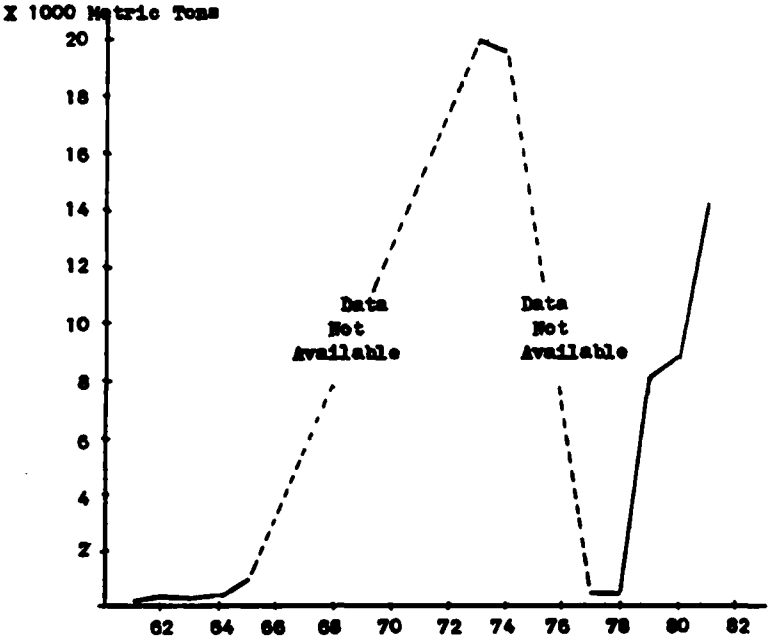


Figure 2-4: Annual Chromium Imports in Taiwan, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

China Steel Corporation, a government-owned enterprise, operates the only integrated iron and steel mill at Kaohsiung. This complex is relatively new and construction of the second blast furnace was completed in 1982, so production can be expected to rise, depending on the market situation.[25] The second stage expansion of this integrated steel complex is very modern with computer-controlled oxygen furnaces and a continuous bloom and basic slab casting system. Per capita output is 350 tons per man per day, slightly more than the United States' productivity, and four times that of the United Kingdom.[28] The iron and steel mill has a 2,600,000 ton-per-year capacity including production of billet steel, plate steel, wire rods, and bars. The government has temporarily postponed

plans to double its capacity because of the world market situation. This expansion will increase the capacity to 5.7 million tons per year and will be designed to produce steel for heavy industry, shipbuilding, automobile manufacturing, and machinery manufacturing.[29] Figure 2-5 shows the annual production and imports of iron ore in Taiwan.

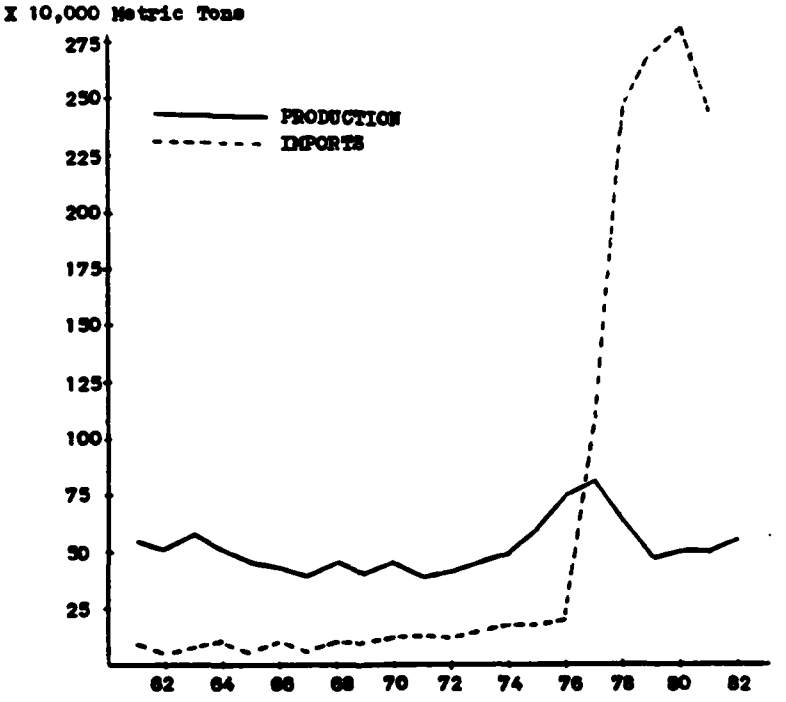


Figure 2-5: Annual Production and Imports of Iron Ore in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Figure 2-6 shows annual production, imports, and exports of iron and steel in Taiwan. Because of the lack of domestic iron ore reserves, Taiwan has established a large shipbreaking industry capable of docking and dismantling 72 ships at a time. This industry represents 90 percent of Taiwan's steel imports.[25]

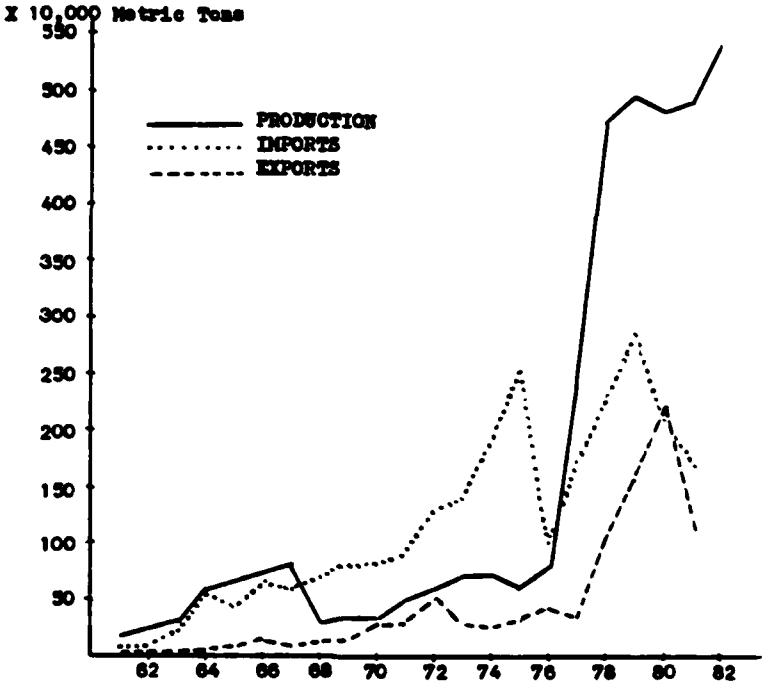


Figure 2-6: Annual Production, Imports, and Exports of Iron and Steel in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

MANGANESE

Taiwan has limited reserves of manganese, mostly occuring as boulders and outcrops of psilomelane and pyrolusite. Small lenticular ore bodies in chlorite schist country rock range from 20 meters thick down to 50 centimeters. Most of the manganese occurs in the east, and also includes small amounts of rhodonite in streams and river beds.[6] Because of its geological occurrence, manganese is difficult and uneconomical to mine, so Taiwan imports virtually all of the manganese used in its steel industry. The main sources of supply are Gabon and South Africa. Figure 2-7 shows annual imports of manganese ore and ferromanganese in Taiwan.[25]

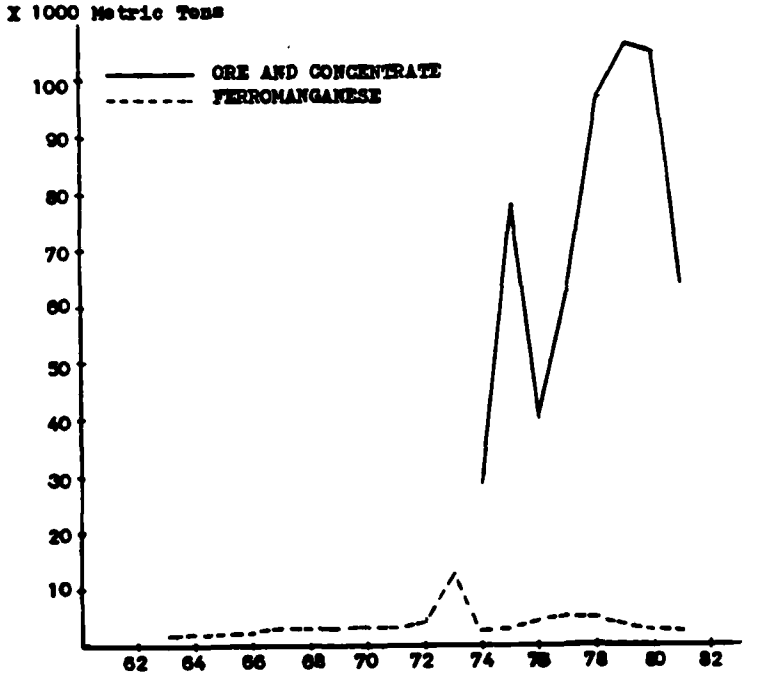


Figure 2-7: Annual Manganese Imports in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

NICKEL

Taiwan is also totally dependent upon imports for nickel supplies, but the level of consumption is quite low. With the expansion of the steel industry since 1976, the import requirements for nickel have begun to rise. Figure 2-8 shows annual nickel imports in Taiwan. Most of these imports are imported from Japan as scrap.[8]

ALUMINUM

Bauxite was discovered in northern Taiwan in 1976, containing 20-45 percent Al_2O_3, over a large area, but the silica content is high, making it very costly to process. Tests were conducted on its beneficiation, and concluded that it

could be processed to 55 percent Al_2O_3 with less than 5 percent silica. The entire project is still in the prospecting stage.[27]

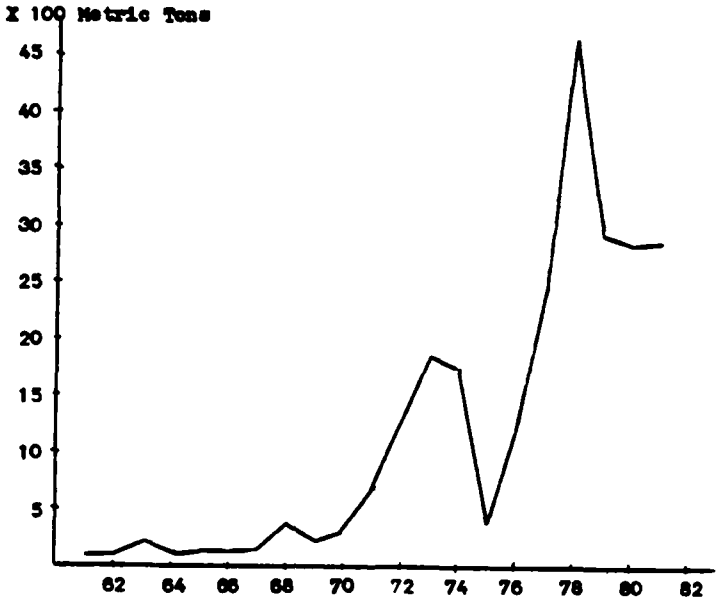


Figure 2-8: Annual Nickel Imports Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Taiwan Aluminum Corporation, a wholly government-owned company, operated two smelters in Kaohsiung until 1981, when Kaohsiung I was shut down because of inefficiency and lack of pollution control equipment. Kaohsiung II, with an annual capacity of 50,000 tons, has never been able to operate at more than 43-61 percent of capacity. The high cost of electricity and low prices on the world market have been blamed for the low productivity. Taiwan Aluminum Corporation has had the largest losses of all government companies, amounting to over $50 million in 1982, and no prospect of improving. As a result, the government is planning on shutting the smelter down, and concentrate on downstream operations. Alcoa Aluminum Company of

America has entered into a joint venture with Taiwan to make rolled aluminum products for the Taiwan market. The total cost of the venture is $100 million and Taiwan Aluminum Corporation has leased its smelters, can plant, and mills to the venture.[30] Ingots imported from Canada will be the major source of aluminum.[25] As a result of this venture, aluminum imports will change dramatically to refined ingots rather than ores and oxides. Figure 2-9 shows annual production, imports, and exports of aluminum in Taiwan. The sudden decline in imports and production after 1980 is a result of closing Kaohsiung I.[8]

COPPER

Copper deposits in Taiwan are hydrothermal copper-gold-silver deposits and cupriferous pyrite deposits containing chalcopyrite, pyrite, and pyrrhotite. Gold is such an important byproduct of copper mining that in many cases, copper is considered to be the secondary metal in extraction operations.[6] Small low-grade porphyry deposits were operated in the 1960's, but were closed down because of a lack of profitability.[27] Domestic copper reserves, for the most part, were depleted in 1968, and by 1972, the government abandoned all copper exploration efforts because of consistently low grades being encountered.[27] In 1974, domestic mine production increased back up to 2000 tons of copper metal per year as a result of a bacteria leaching process which allowed for the extraction of cement copper from ore in an economically efficient manner, but copper ore and concentrate was readily available from the Philippines,

so this new microbacterial mining process has remained at a relatively low scale.[8]

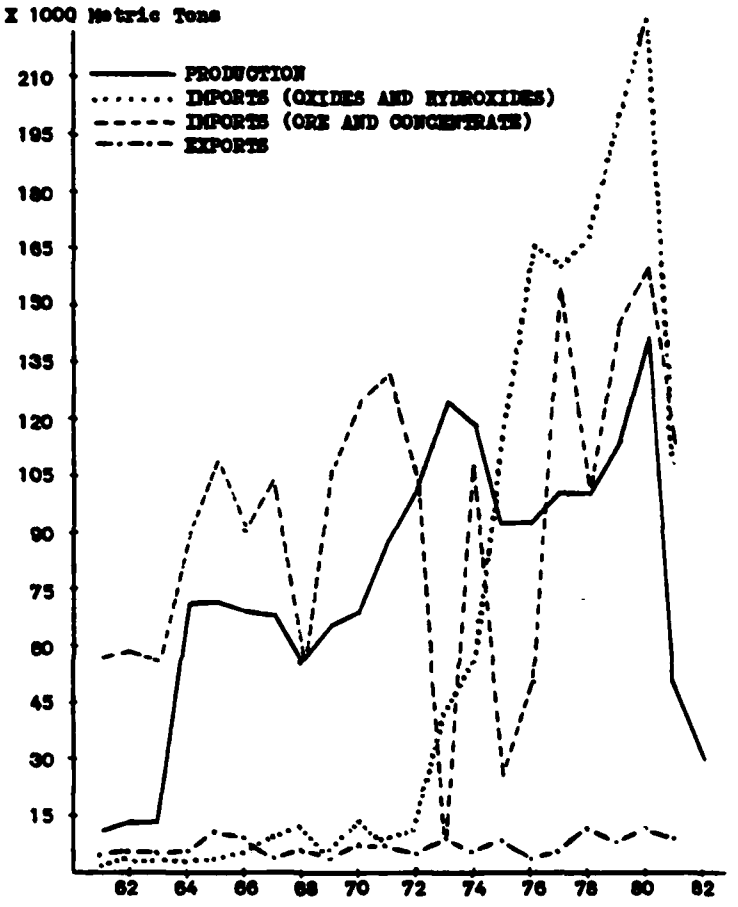


Figure 2-8: Annual Production, Imports, and Exports of Aluminum in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Taiwan Metal Mining Corporation, a government-owned company, operates a monopoly on copper production and processing. One smelter-refinery with a capacity of 18,000 tons per year, has been operating since 1947. The other smelter, in Keelung, has a capacity of 50,000 tons per year, and opened in 1980.[8] This smelter-refinery processes copper ore and

concentrate in a Lurgi fluid bed furnace, smelts the copper into matte in an electric arc furnace, and then processes the waste in another Lurgi fluid bed furnace to make sulfuric acid for fertilizer production.[22] Plans to expand this refinery's capacity to 80,000 tons per year in 1983 were postponed, but the government still maintains long-term plans of eventually expanding the capacity to 130,000 tons.

Figure 2-10 shows the annual production, imports, and exports patterns of copper in Taiwan. The depletion of copper reserves in 1968 and the opening of the Keelung smelter-refinery in 1980 are events which significantly affect the patterns shown. Taiwan has recently entered into a long-term contract with Indonesia and the Philippines to ensure future supplies.

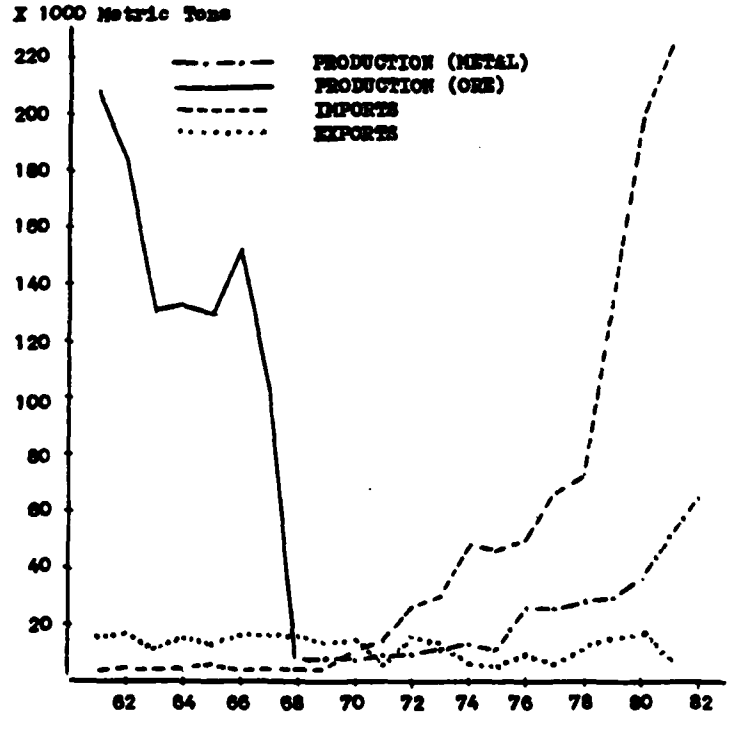


Figure 2-10: Annual Production, Imports, and Exports of Copper in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

LEAD AND ZINC

Taiwan does not produce any primary lead or zinc so industrial demand for these metals is satisfied with imports.[8] Requirements for lead have been increasing rapidly since 1975, mainly because of the extremely rapid surge in automobile ownership in the country, as mentioned previously. Figure 2-11 shows patterns in annual production, imports, and exports of lead in Taiwan.

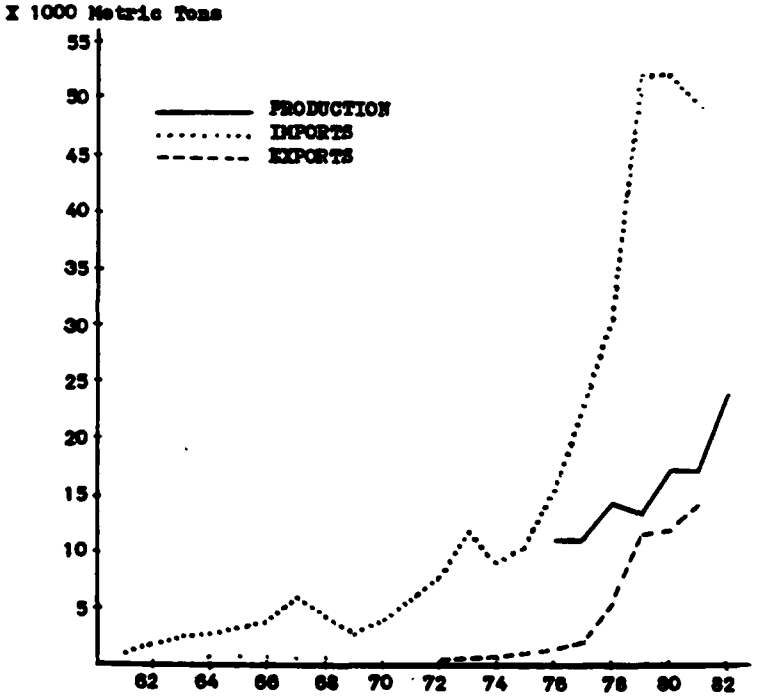


Figure 2-11: Annual Production, Imports, and Exports of Lead in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Annual demand for zinc in Taiwan is about 60,000 tons, increasing about 10 percent per year. In 1981, Taiwan Metal Mining Corporation shelved plans to construct a zinc smelter and instead has entered a 50 percent joint venture in a South

African zinc mine. Taiwan's share in the venture was to construct an 80,000 ton-per-year zinc smelter in South Africa. Along with this venture, consideration is being given to Taiwan's possible involvement in a copper and lead smelter in South Africa.[31] Figure 2-12 shows annual import and export patterns of zinc in Taiwan.

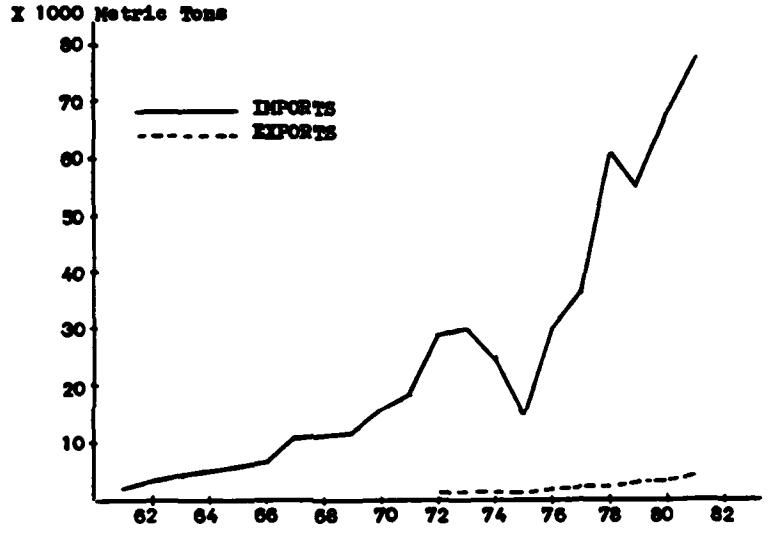


Figure 2-12: Annual Imports and Exports of Zinc in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

TIN

Taiwan is 100 percent import-dependent upon tin from Malaysia, and consumption in the country began to increase rapidly in 1974 with the expansion of Taiwan's steel and food canning industries. Figure 2-13 shows the import patterns of tin in Taiwan. Demand has been curtailed in the 1980's because of the world recession.

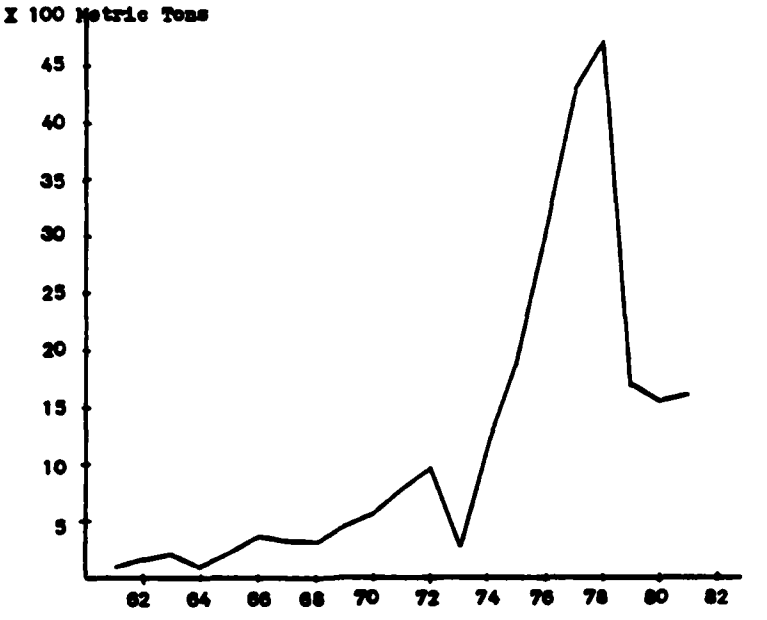


Figure 2-13: Annual Tin Imports in Taiwan, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

TITANIUM

Although Taiwan has beach placer deposits containing ilmenite and leucoxene (containing rutile), domestic production of titanium is almost non-existent. As a result, titanium oxides, for manufacturing pigments, are imported, mainly from Japan, West Germany, and the United States.[25] Figure 2-14 shows import patterns of titanium in Taiwan.

MERCURY

Native mercury and cinnabar occur in northern Taiwan in gold-copper and gold veins, but have not been economically exploitable since 1963 because of containing only 0.2-0.4 percent mercury.[6] As a result, Taiwan imports mercury from Japan, Belgium, and Mexico. Figure 2-15 shows the import pattern of

mercury in Taiwan. The quantities are relatively low, indicating a major shipment every 2-3 years.[25]

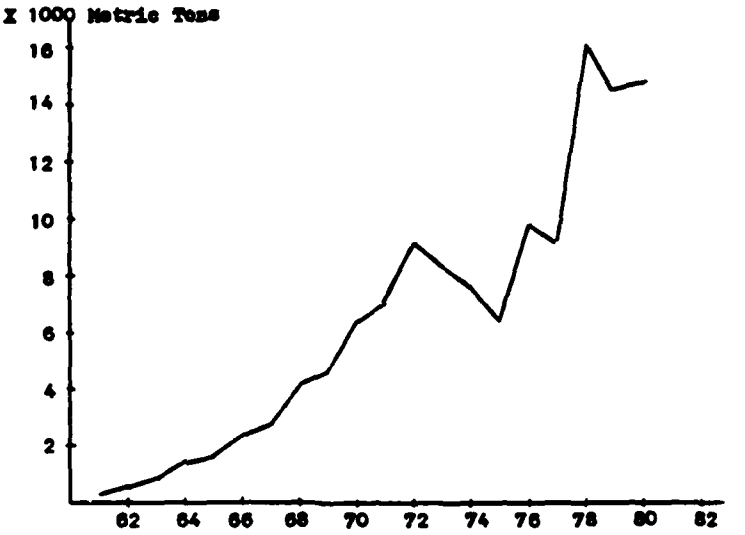


Figure 2-14: Annual Imports of Titanium in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

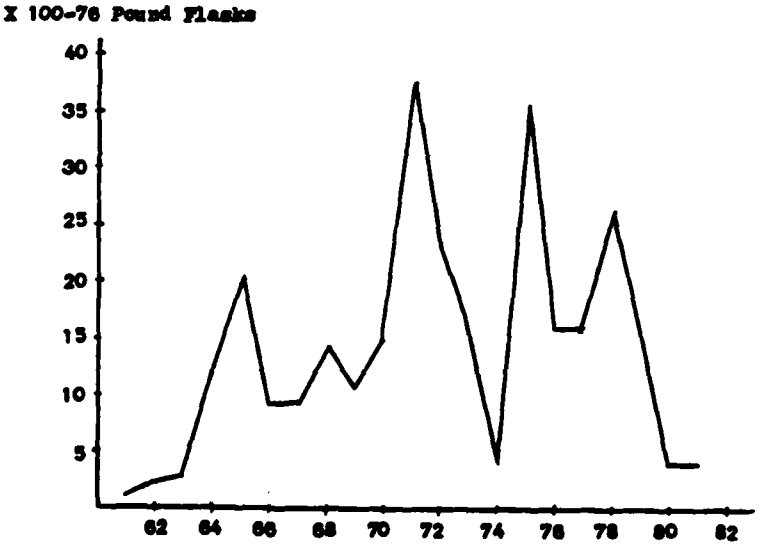


Figure 2-15: Annual Imports of Mercury in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GOLD

Gold is widely distributed in Taiwan in hydrothermal veins and placer deposits, although most of the placer deposits have been depleted since 1975. Gold, as a mineral commodity, ranks second to coal in total value, and nearly all gold deposits contain silver alloys, which makes silver and gold production patterns very similar.[6] Gold is mainly produced from vein deposits in the Chinkwashih mine, but in 1981, with world gold prices increasing, production was expanded and now some placer gold mining is also being done. Figure 2-16 shows annual production, imports, and exports patterns of gold in Taiwan. The large-scale exports of gold in 1980 and 1981 were a direct result of the almost gratis purchases of pure gold from the IMF when Taiwan's membership was terminated in 1979.[11] The gold metal processed in Taiwan is separated from the ore using flotation methods.[27]

SILVER

Silver production, as a byproduct of gold, has been steady and is presently increasing in volume, but the level of production in Taiwan represents less than 10 percent of domestic consumption. As a result, Taiwan is a net importer of silver, receiving it from Japan, West Germany, and Hong Kong. Figure 2-17 shows silver production and import patterns in Taiwan.[25]

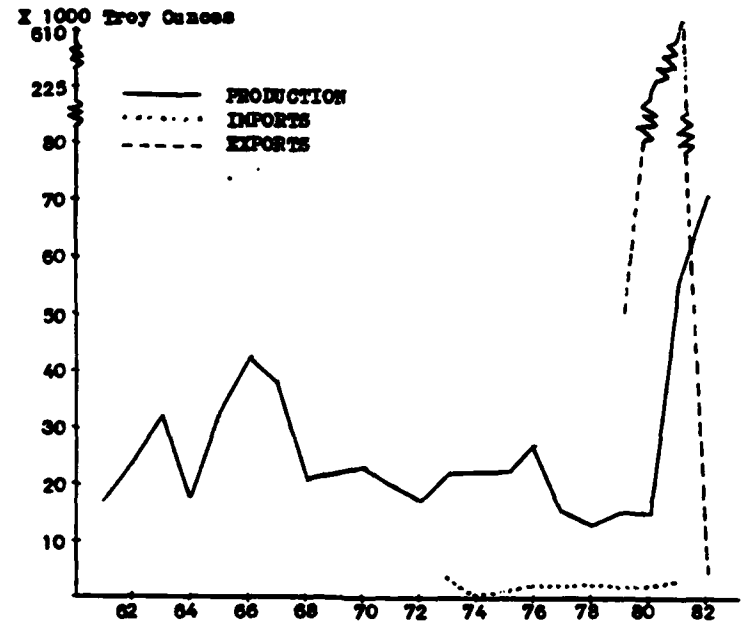


Figure 2-16: Annual Production, Imports, and Exports of Gold in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

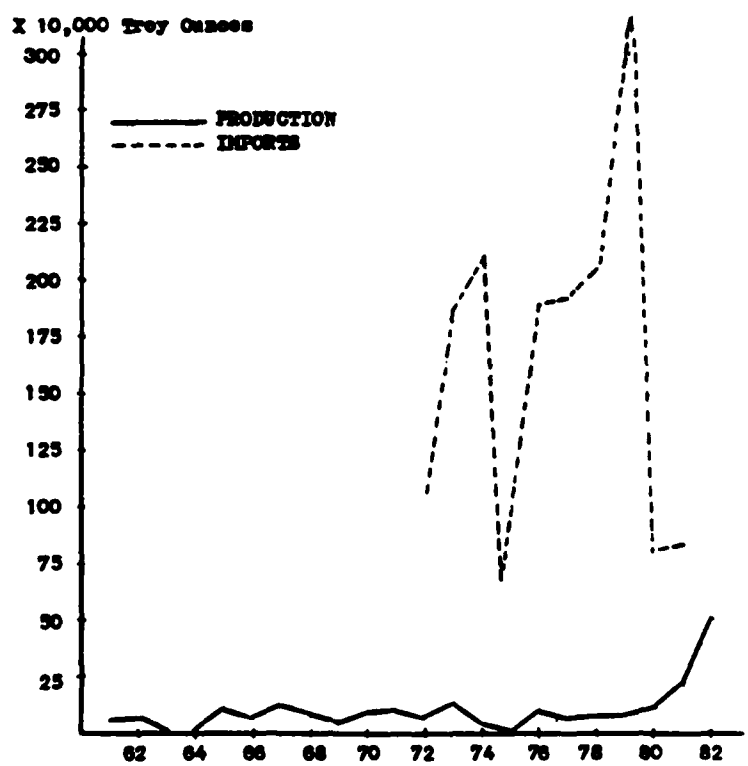


Figure 2-17: Annual Production and Imports of Silver in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

PLATINUM GROUP METALS

Taiwan does not report any production of platinum group metals among their mineral statistics, but sizeable quantities were exported in the 1970's, indicating either an unloading of excesses from imports or actual production. Figure 2-18 shows the import and export patterns of platinum group metals in Taiwan. Most of the trade activity involves platinum metal.[25]

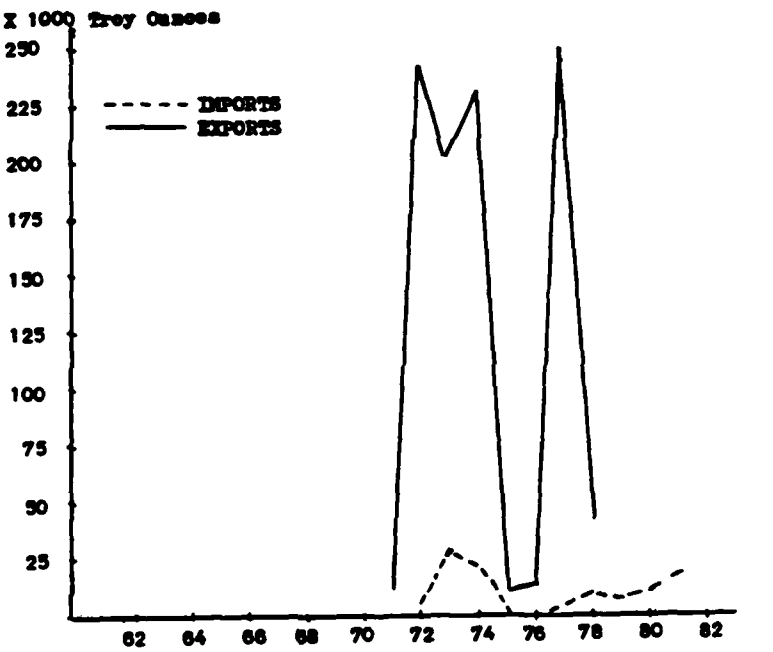


Figure 2-18: Annual Imports and Exports of Platinum Group Metals in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

NON-METALLIC MINERALS

ASBESTOS

Taiwan produces small quantities of asbestos from schistose rocks in the eastern part of the island where it occurs in irregular veins, thin lenses, and small pockets, as very discontinuous deposits associated with serpentine

contacts with igneous rocks.[6] Domestic demand has risen significantly since 1971, and to meet these requirements, Taiwan imports about 90 percent of all asbestos consumed.[8] Figure 2-19 shows production and imports patterns of asbestos in Taiwan.

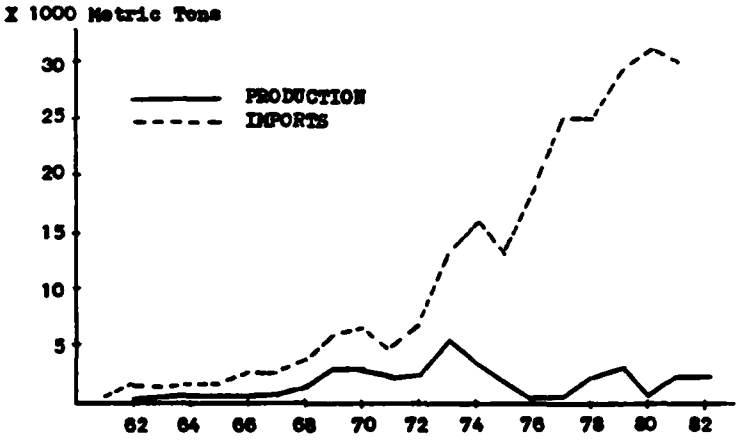


Figure 2-19: Annual Production and Imports of Asbestos in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GRAPHITE

Taiwan is 100 percent import-dependent for graphite supplies, importing them from South Korea, India, and Japan.[25] Figure 2-20 shows annual graphite import patterns in Taiwan.

LIME AND LIMESTONE

Extensive amounts of limestone occurs in Taiwan in Tertiary age deposits consisting mainly of reefs and crystalline limestone.[6] These deposits are spread throughout the island, but are thickest in the southwestern and eastern portions. Production from these deposits is sufficient to meet the domestic requirements in the country, an important factor

in the cement, fertilizer, and dimension stone industries in Taiwan. Figure 2-21 shows the annual production of lime and limestone in the Republic of China.

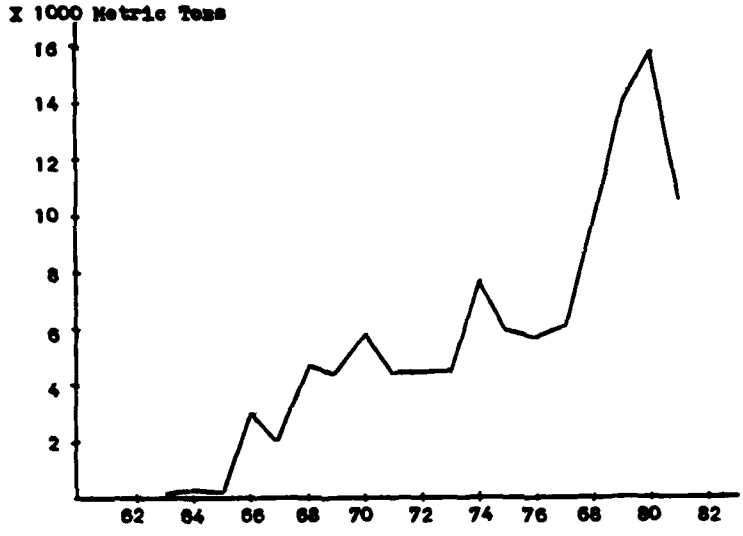


Figure 2-20: Annual Imports of Graphite in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

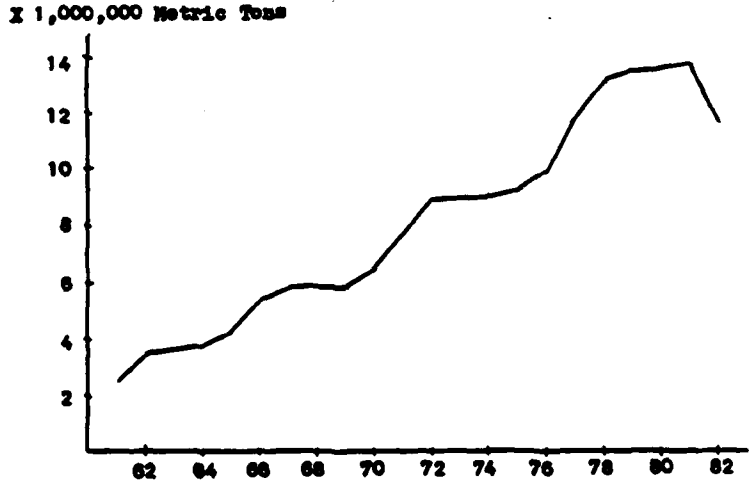


Figure 2-21: Annual Production of Lime and Limestone in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

DOLOMITE

Commercially important dolomite quarries are located in the Tachoshiuchi stream north of Hualien. Other quarries include Hoping, Hojen, and Chungteh. However, the most important deposit is the Chingchanangshan, which was developed in 1977 to provide dolomite for China Steel's iron and steel complex in southern Taiwan.[31] Figure 2-22 shows the production pattern of dolomite in Taiwan. The recent significant increase in production is from the Chingshangshan Mine.

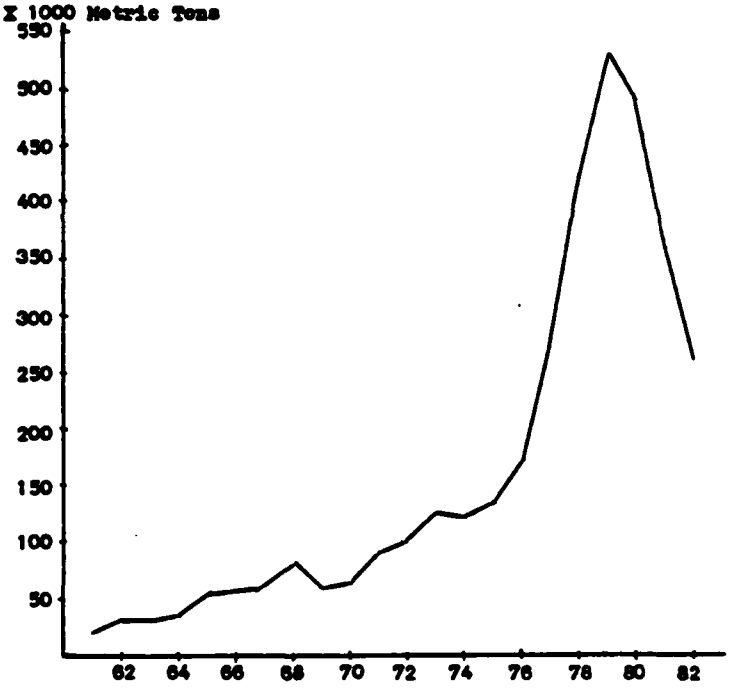


Figure 2-22: Annual Production of Dolomite in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

FERTILIZER

Fertilizer consumption in Taiwan has steadily increased over the past 20 years, but Taiwan has no potash and only very

small apatite deposits, making the country heavily dependent upon imported raw materials for fertilizer production. Taiwan's fertilizer industry is dominated by large government-owned companies, including China Phosphate Industries Corp., China Phosphate Corp., Kaohsiung Aluminum Sulphate Corp., Taiwan Metal Mining Co., and Taiwan Fertilizer Co. Ltd. Depressed demand and excess production capacity in Taiwan and throughout the Far East has dampened the industry since 1980. As a result, at present, Taiwan does not plan to increase capacity in the fertilizer industry, but a 99,000 ton-per-year sulfuric acid plant at Kaohsiung is being built and should be completed in 1984.[25] Figure 2-23 shows the annual production, imports, and exports patterns of fertilizer in Taiwan.

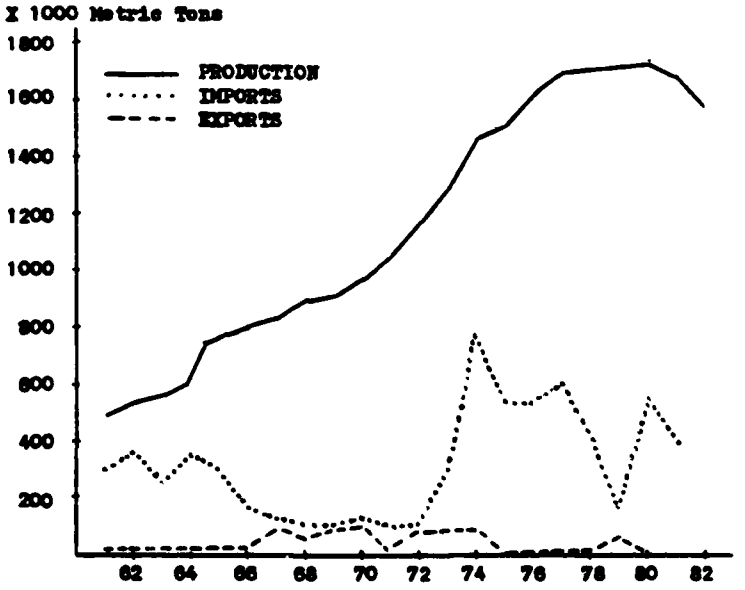


Figure 2-23: Annual Production, Imports, and Exports of Fertilizer in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

FELDSPAR AND FLUORSPAR

Taiwan used to produce sufficient quantities of feldspar and fluorspar to be self-sufficient, but due to a lack of profitability, production declined significantly in the mid-1960's. More recently, with the expansion of the steel industry in Taiwan, substantial quantities of fluorspar and feldspar have been imported from the Republic of Korea, Japan, and Thailand.[25] Figure 2-24 shows the annual production, imports, and exports patterns of feldspar and fluorspar in Taiwan.

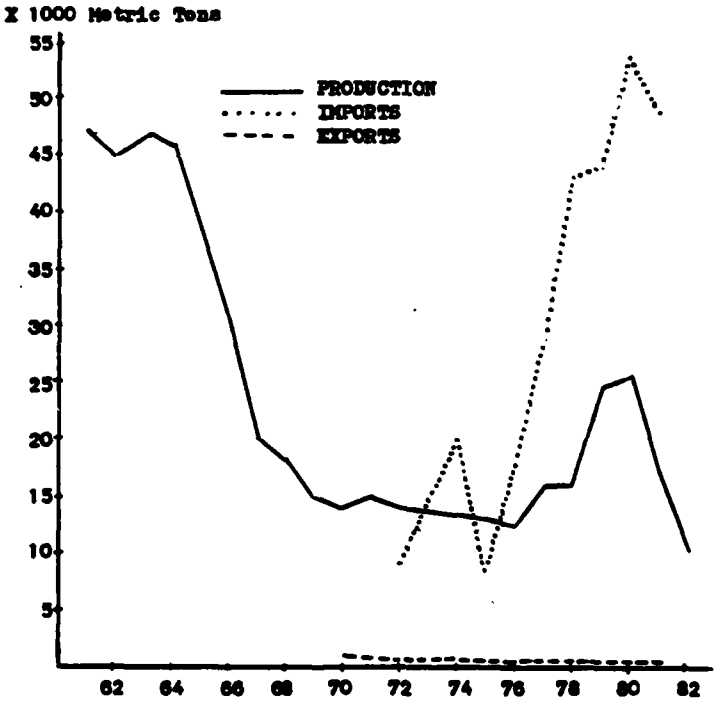


Figure 2-24: Annual Production, Imports, and Exports of Feldspar and Fluorspar in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

CEMENT

Taiwan's cement industry is comprised of 17 plants operated by 11 companies. Total industrial capacity was 15.3 million tons per year in 1982.[25] Taiwan Cement Corp., government-owned, was the largest with a capacity of 5.27 million tons from 4 plants. Cement output in Taiwan has been nearly at capacity for almost 20 years, and although some cement is exported, most of the production is consumed domestically. Figure 2-25 shows annual production and export patterns of cement in Taiwan. Production in 1982 dropped because total construction in Taiwan was down 33 percent from 1981 due to the worldwide recession.[25]

TALC

Small talc deposits occur in eastern Taiwan, associated with the asbestos deposits.[6] Production has been quite erratic over the past 20 years, mainly due to the small-size deposits. As each deposit is developed, production increases until the deposit is depleted.[8] Figure 2-26 shows the annual production, imports, and exports trends of talc in Taiwan.

SALT

All salt produced in Taiwan is by Taiwan Salt Works, a government-owned monopoly. The salt fields in Taiwan are distributed along along the southwestern coast, but a majority of salt production is crude salt from solar evaporation ponds. Production of salt began to decline dramatically after 1971, but to relieve the salt shortages, a 100,000 ton-per-year ion

exchanging membrane salt plant, furnished by two Japanese firms, was completed near the end of 1974.

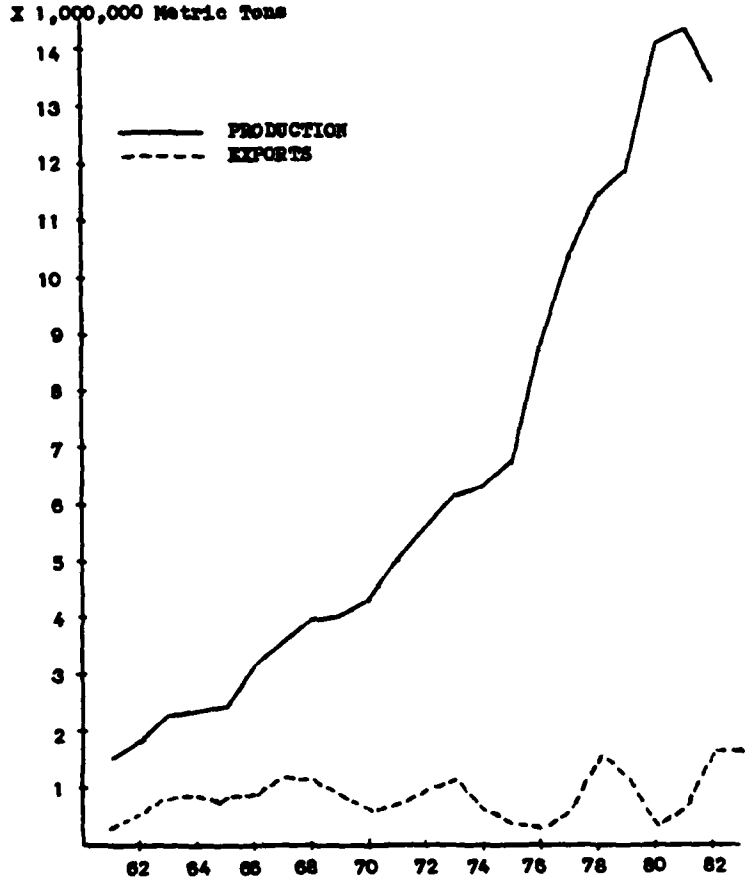


Figure 2-25: Annual Production and Exports of Cement in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Figure 2-27 shows the annual production, imports, and exports patterns of salt in Taiwan. Imports rose in the early 1970's, fell after the ion-exchange plant was completed, and is now increasing again due to the heavy industrial use of salt. The largest consumer of salt in Taiwan is the soda-chlorine industry, which produces caustic and liquid soda, soda ash, and liquid chlorine.[8]

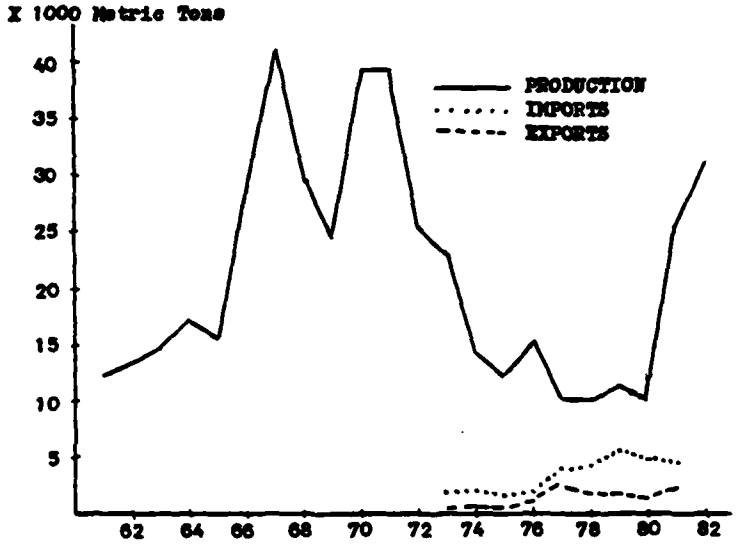


Figure 2-26: Annual Production, Imports, and Exports of Talc in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

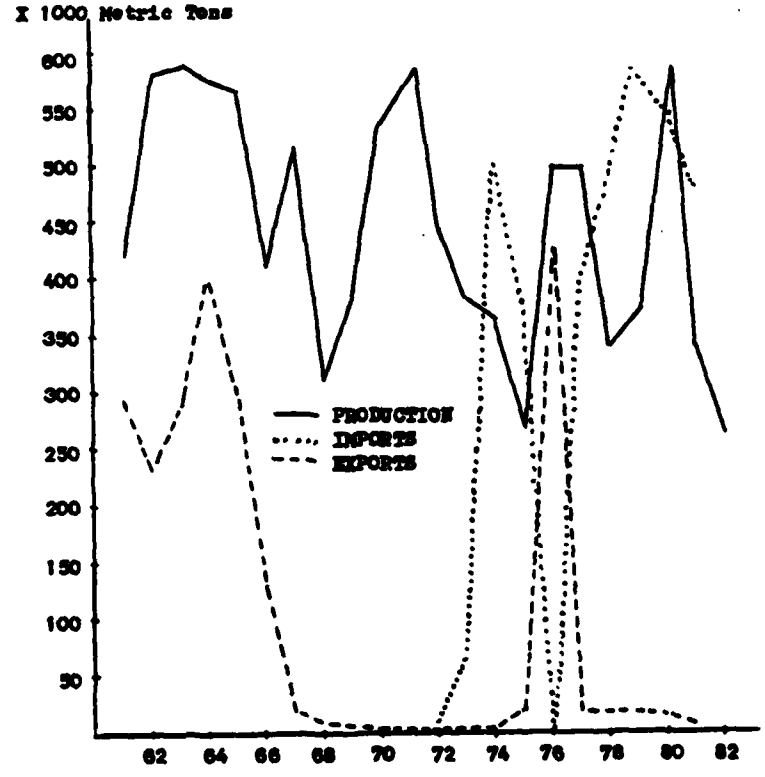


Figure 2-27: Annual Production, Imports, and Exports of Salt in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

SULFUR

Economically exploitable deposits of native sulfur occur in Taiwan from ancient volcanics. Elemental sulfur is also found in hydrothermal sulfide deposits. Sulfur is also obtained by roasting pyrites from open pit mines and from vapor collectors.[6] Other important sources of sulfur in Taiwan are the manufacturing of sulfuric acid as a byproduct of hyrothermal copper-gold-silver deposits and cupriferous pyrites.[27] Figure 2-28 shows annual production, imports, and exports patterns of sulfur in Taiwan. Production has been limited to secondary processes and is mainly from the Kaohsiung II refinery of the Chinese Petroleum Corp. and from copper mining.

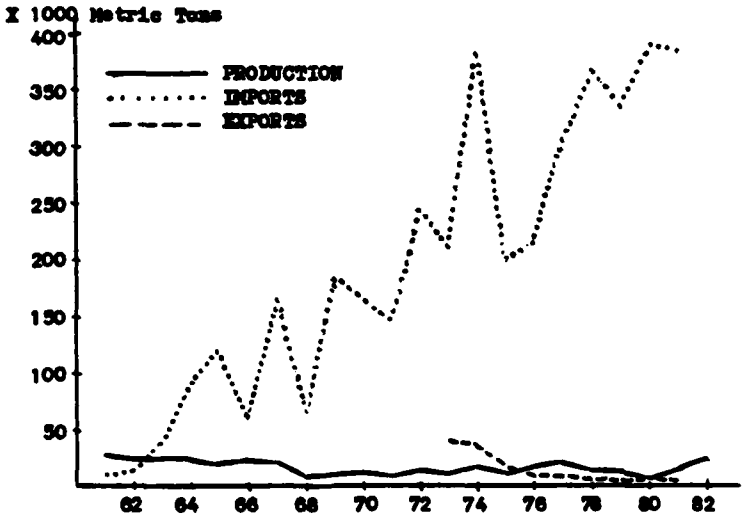


Figure 2-28: Annual Production, Imports, and Exports of Sulfur in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GYPSUM

Taiwan has very limited domestic supplies of gypsum. Figure 2-29 shows that nearly all of domestic consumption of gypsum is satisfied by imports, mainly from Japan, Australia, and the Republic of Korea.

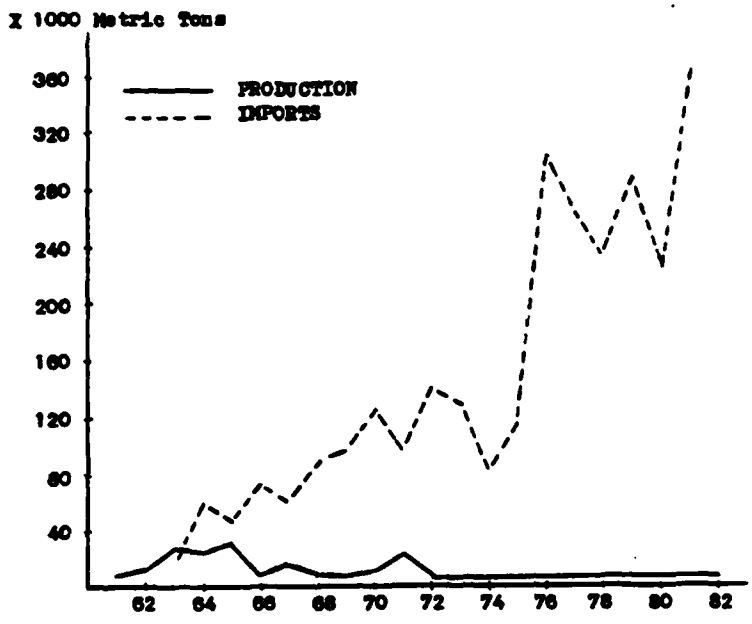


Figure 2-29: Annual Production and Imports of Gypsum in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

PYRITE AND PYRRHOTITE

Production of pyrite and pyrrhotite is discussed because of their important association in Taiwan with the production of copper and sulfur. Figure 2-30 shows the sharp decline in production of pyrite and pyrrhotite in the early 1970's, a major contributing factor to the decline in domestic copper and sulfur production.[8]

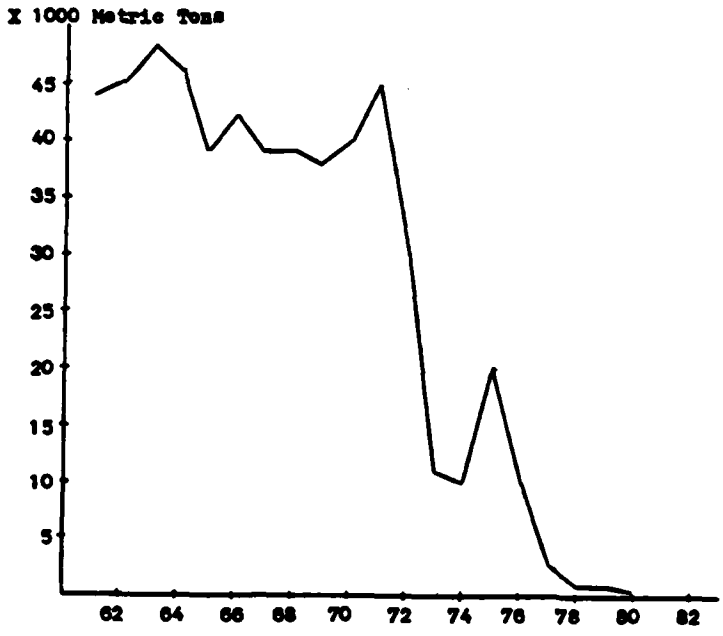


Figure 2-30: Annual Production of Pyrite and Pyrrhotite in Taiwan, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GOVERNMENT POLICY STRATEGIES

The Government of the Republic of China had been severely distracted from concentrating on industrial development until the 1970's. Ever since the conquest of the mainland by Communist forces, the foreign and domestic policy of Taiwan has revolved around a single goal: recovery of the mainland; but as years passed by, those Chinese who were driven from the mainland have steadily diminished in proportion to the population. The People's Republic of China has also developed during the same time, and as a result, Taiwan no longer possesses the military power to overthrow the Communist regime on the mainland.[32]

In the past 30 years, Taiwan has grown into a fierce

international competitor, but because of many of Taiwan's trading partners' trade deficits, Taiwan has had to carefully maneuver its economic policy to avoid stagnation. In the past, Taiwan's international trade depended almost completely on the United States and Japan. Now Taiwan has greatly diversified its world trade, but must continue to diversify more.[3] Taiwan plans to step up the development of technology-intensive industries such as petrochemical, chemical, basic metals, cement, and food processing, and the government is offering special incentive programs for private firms to increase their budgets for research and development in these areas.[3]

In recent years, construction has attained the highest growth rate of the entire business spectrum and Taiwan is almost self-sufficient for materials, but demand for iron and steel, asbestos, and high quality equipment is expected to skyrocket.[3]

Taiwan was expelled from the World Bank and the International Monetary Fund. This expulsion sent the country scrambling for new ways to obtain capital. In 1981, after changing its policy several times, Taiwan opened the doors to foreign stock brokers. This time, many former restrictions were removed.[33] This was done only after a major revision of the stock market wystem in Taiwan. Previous procedures had led to such a corrupt system that investing in the Taiwan Stock Market was worse than outright gambling.[34]

The government and the Taiwan corporations maintain a common goal: to stabilize supplies of resources and raw

materials, to reduce transportation costs, to utilize foreign energy sources for production, to counteract protectionism in Western markets, to change growth policies in order to prosper, and to expand the nation's overseas contracts.[35] To accomplish these goals, Taiwan companies are entering into joint ventures overseas, concentrating in the United States, Southeast Asia (especially Indonesia), and in the Middle East. Taiwan Fertilizer Company and a state-run Saudi Arabian company constructed a $357 million fertilizer plant in Saudi Arabia. This plant ensures Taiwan of Fertilizer supplies while consuming Saudi Arabia's excess natural gas.[35] Formosa Plastic's Group and Louisiana Chemical and Plastic Corp now operate a petrochemical facility in Texas.[35] The Sampo Company of Taiwan has numerous projects in Indonesia in the lumber and paper production industry.[35] In effect, Taiwan has had to abandon past practices in order to prosper. Taiwan used to be able to produce, using low domestic costs and unlimited energy from Western sources. The government's policy has moved away from consolidating the nation's assets and resources at home.[35] Other overseas projects include Taiwan Power Company conducting coal and uranium mining and exploration operations in Paraguay and the Chinese Petroleum Corp. exploring for oil in Southeast Asia, Columbia, and South America.[36]

Taiwan has had to cope with declining foreign investment, with 1983 investments from foreign sources 14 percent lower than in 1982. Japanese companies led investments with $156.4 million, United States' companies were second with $39.9

million, and European companies were third with $9.5 million.[37] To counteract this problem, the Taiwanese Government has developed several foreign investment incentives: (1) foreign investments are afforded the same incentives and privileges as domestic investments; (2) foreign investors may have 100 percent ownership; (3) all net profits and interest earnings may be converted or remitted; (4) foreign investors may apply for repatriation of 20 percent of the total investment each year, starting one year after the first year of operations; (5) protection of government expropriation or requisition for 20 years, if foreign investment exceeds 45 percent of the total registered capital; and (6) protection of patents, trademarks, and copyrights.[4]

RELATIONS WITH THE UNITED STATES

Though the United States Government terminated formal diplomatic relations with the Republic of China on January 1, 1979, the commercial, cultural, scientific, and other relations between the two countries have by no means weakened. The two way trade between the United States and Taiwan has reached record-breaking proportions. In 1981, total trade was over $12.9 billion.[4] The United States is experiencing trade deficits with Taiwan, but the Taiwanese Government is actively pursuing corrective action.

RELATIONS WITH OTHER COUNTRIES

EAST ASIAN AND PACIFIC COUNTRIES

The relationship between Taiwan and East Asian and Pacific ountries has been reinforced with conferences and mutual agreements in various areas of common interest. Though lacking official diplomatic relations, the Republic of China maintains friendly relations with Japan, Thailand, the Republic of the Philippines, Malaysia, Indonesia, Australia, New Zealand, and numerous smaller countries and islands. Economic agreements and numerous long-term contracts for raw materials exist between Taiwan and Japan, Australia, Indonesia, and the Philippines.[4]

AFRICAN NATIONS

Taiwan maintains formal diplomatic relations with several African nations, including the Kingdom of Lesotho, the Republic of Malawi, the Republic of South Africa, and Swaziland.[4]

EUROPEAN COUNTRIES

Taiwan has various cultural, economic, and trade offices in 14 European countries, but maintains formal diplomatic relations only with the Holy See. Two way trade between Taiwan and Europe is significant, and despite the worldwide recession in the beginning of the 1980's, trade was $4.84 billion. Nine European banks have opened in Taiwan since 1980, and investments have been increasing rapidly. Over 154 applications to provide technical assistance have been approved

since 1954.[4]

LATIN AMERICAN COUNTRIES

Taiwan maintains formal diplomatic relations with most of the Latin American countries and participates in numerous economic, technological, and cultural exchanges.

TAXES IN TAIWAN

Since 1964, Taiwan's Government has consistently run a budget surplus in spending versus tax revenues. This surplus amounted to $112.5 million in 1981. Taxes account for 63.8 percent of total government revenues, monopoly earnings represent 7.8 percent, and other income makes up the remaining 28.4 percent.[4] Government taxes have increased more rapidly than the gross national product. Although exact tax rates are not published, individual and corporate taxes amounted to 19.8 percent of the gross national product in 1980.[4]

POLICY ANALYSIS CONSIDERATIONS

Having no established diplomatic relations with the Republic of China, the United States Government has very few formal dealings with the country. Since 1979, the United States has recognized the People's Republic of China as the legitimate Chinese Government, and efforts have been concentrating on relations with the mainland. The change in U. S. foreign policy was not totally at the expense of Taiwan. The United States has remained a strong economic trader with the island country, as well as other international exchanges.

From a policy perspective, the United States cannot modify relations with Taiwan without jeopardizing the newly-established relations with the mainland Chinese Government. Such a move would cause tension between superpowers. Additionally, it is in the best interest of the United States to favor relations with the mainland China over those of Taiwan because of the shear size of China, its possible mineral resources, investment opportunities for U. S. banks and firms, and its potential alliances with the Soviet Union. With the United States as a pseudo-ally of China, it can be assumed that China and the Soviet Union will not team up against the United States.

From a minerals standpoint, Taiwan has been extensively explored and does not possess any potential as a source of raw materials to the U. S. Although the United States does export raw materials and minerals to Taiwan, only precious and semi-precious stones are imported into the U. S. from Taiwan.[8]

Based on the focus of the present diplomatic efforts between the United States and the People's Republic of China, the U. S. policy concerning the Republic of China will very likely remain one of informal ties in the economic, scientific, and cultural areas only.

REFERENCES

1 Frederick H. Shaffee, et al., Area Handbook for the Republic of China (Washington, D. C.: U. S. Government Printing Office, 1982).

2 U. S. State Department, et al., Countries of the World and Their Leaders Handbook, 1984 (Detroit: Gale Research Company, 1984).

3 Betty W. Patrick, "Taiwan's Development into Industrial Economy Creates Demand for Advanced Capital Equipment," Business America, January 11, 1982.

4 Republic of China Government Information Office, Republic of China: A Reference Book (Taipei: United Pacific International Publishing, Inc., 1983).

5 Arthur Jones, "Where Adam Smith Meets Confucius," Forbes, December 19, 1983.

6 Chun-Sun Ho and Chin-Nan Lee, Economic Minerals of Taiwan *Geological Survey of Taiwan* (Taipei: 1963).

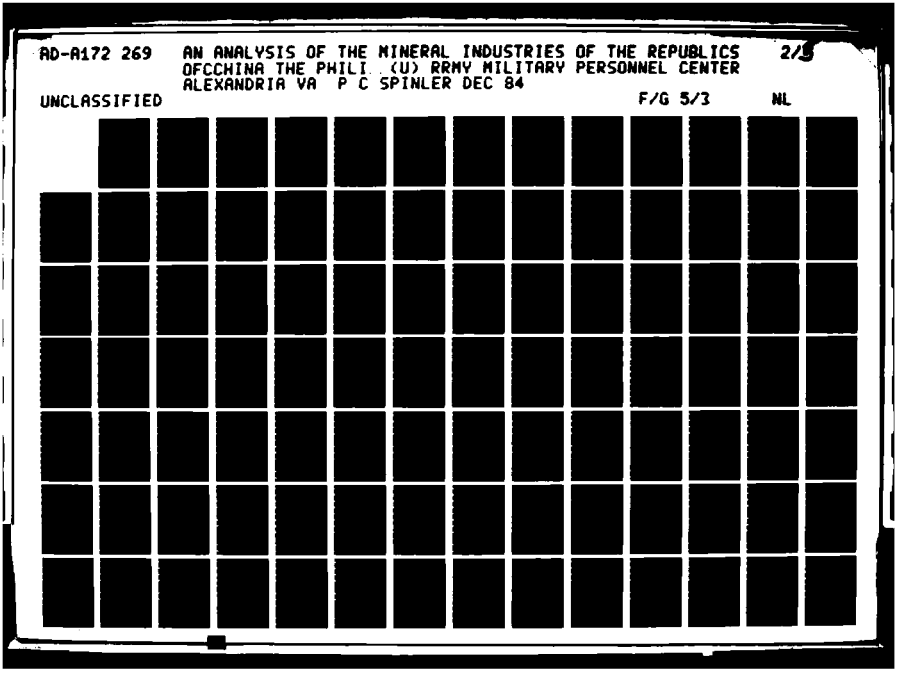
7 Taiwan Council for Economic Planning and Development, Taiwan Statistical Data Book 1983 (Taipei: Government Bureau of Printing, June 1983).

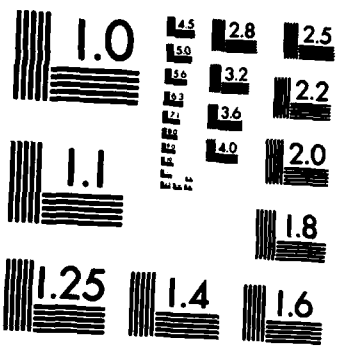
8 U. S. Department of the Interior, U. S. Bureau of Mines, "The Mineral Industry of Taiwan," by Edmund Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1961-1982).

9 Anon., "Taiwan Economic Forecast," Wall Street Journal, February 25, 1983, Sec. 2, p. 30e.

10 Europa Publications Limited, The Europa Yearbook 1983, Vol. 2 (Stanhope, England: Staples Printers Rochester Limited, 1983).

11 Anon., "China's Membership in IMF is Approved; Taiwan is Removed," Wall Street Journal, April 18, 1980, Sec. 2, p. 17e.


AD-A172 269 AN ANALYSIS OF THE MINERAL INDUSTRIES OF THE REPUBLICS 2/5
OFCCHINA THE PHILI (U) RRMY MILITARY PERSONNEL CENTER
ALEXANDRIA VA P C SPINLER DEC 84
UNCLASSIFIED F/G 5/3 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

12 Anon., "China is in, Taiwan is Out, Shows Report by the World Bank," Wall Street Journal, August 10, 1980, Sec. 2, p. 30e.

13 Robert Magnuson and E. S. Browning, "Japanese Bank Sets 'Quiet' Taiwan Loan," Wall Street Journal, April 13, 1983, Sec. 2, p. 30e.

14 Anon., "Austerity Budget Proposed by Taiwan," Wall Street Journal, April 13, 1982, Sec. 2, p. 38e.

15 Anon., "Taiwan Boosts Spending 16 % in FY'82 Budget," Wall Street Journal, March 26, 1981, Sec. 2, p. 29e.

16 Anon., "Export-Import Bank Processes Taiwan Project Credit," Wall Street Journal, May 5, 1982, Sec. 2, p. 29e.

17 Anon., "Taiwan Power Delays Two Nuclear Projects," Wall Street Journal, July 13, 1982, Sec. 2, p. 37e.

18 Anon., "Taiwan; the Economy Puts a Damper on Energy," Business Week, August 9, 1982.

19 Don Shapiro, "Government Scales Down Energy Plans," Journal of Commerce, October 12, 1982.

20 Maria Shao, "Newly Industrialized Taiwan's Pollution Begins to Reach Worrisome Proportions," Wall Street Journal, July 15, 1983, Sec. 2, p. 30e.

21 Michael Boydell, "Port Facilities are Being Upgraded to Expand Taiwan's Shipping Role," Journal of Commerce, October 12, 1982.

22 Anon., "What's Going on in World Mining," World Mining, 1972-1984.

23 Don Shapiro, "Nation's Trade Hits $43.8 Billion, Ranks 19th in World," Journal of Commerce, October 12, 1982.

24 Anon., "Taiwan's Trade Surplus up in September from '82," Wall Street Journal, October 12, 1983, Sec. 2, p. 32e.

25 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of Taiwan," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1982 Reprint).

26 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of Taiwan," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1978-1979).

27 Anon., "Worldwide Survey," World Mining, 1972-1984.

28 John J. Metzler, "New Mill Sharply Boosts Taiwan's Steel Output," Journal of Commerce, March 5, 1982.

29 Anon., "Steel Concern in Taiwan Plans Major Expansion," Wall Street Journal, August 8, 1983, Sec. 2, p. 20e.

30 Anon., "Alcoa Forms Venture with Taiwan Company," Wall Street Journal, October 17, 1983, Sec. 2, p. 3e.

31 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of Taiwan," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1981 Reprint).

32 Melvin Gurtov, Recent Developments in Taiwan, United States Defense Technical Information Center (Santa Monica: The RAND Corporation, February 1967).

33 Anon., "Taiwan May Let Foreigners Buy Stock Again," Wall Street Journal, April 24, 1981, Sec. 2, p. 36e.

34 Diane Ying, "Trading Jungle in Taiwan is Chasing Potential Investors Away From Stocks," Wall Street Journal, November 13, 1980, Sec. 2, p. 31e.

35 Diane Ying, "Taiwan Firms Turn to Foreign Plants, Especially in U. S., to Cope with Problems," Wall Street Journal, August 5, 1980, Sec. 2, p. 31e.

36 Anon., "Taiwan: Push to Build Plants Overseas," Business Week, June 9, 1980.

37 Anon., "Planned Foreign Investment Declines in Taiwan," Wall Street Journal, August 8, 1983, Sec. 2, p. 21e.

CHAPTER THREE:

THE

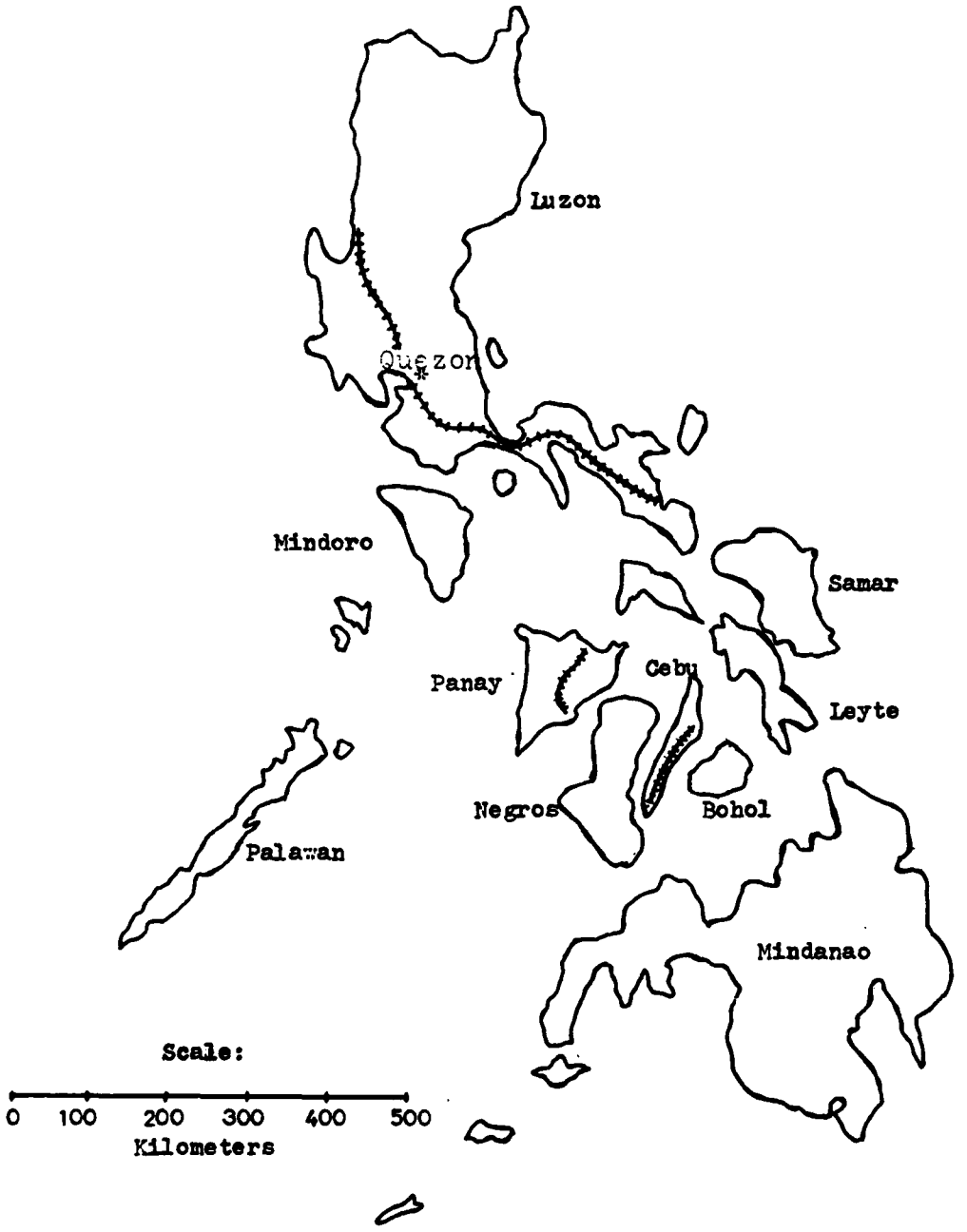
MINERAL INDUSTRY

OF

THE

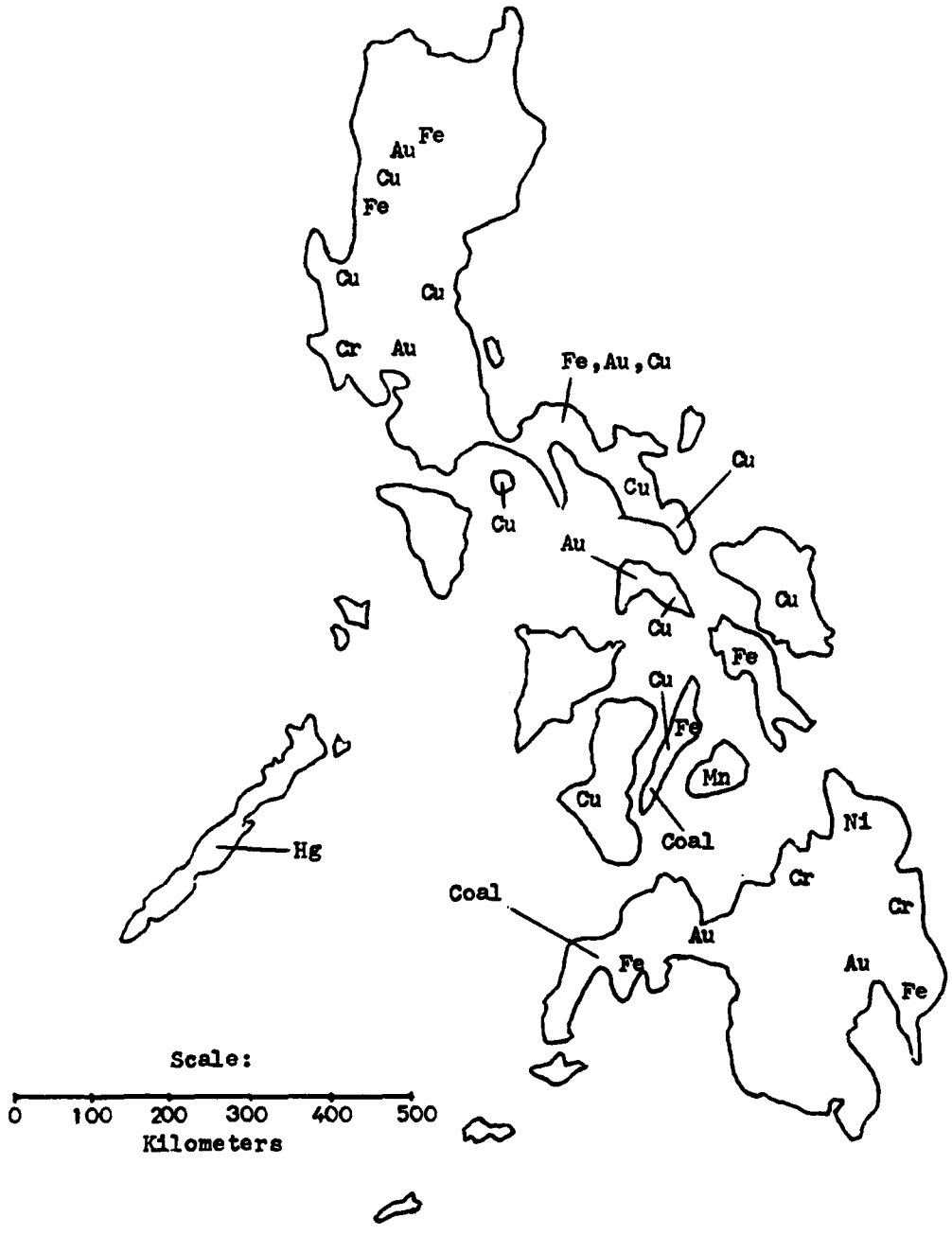
REPUBLIC OF THE PHILIPPINES

Map 3-1. Geographic Map of the Republic of the Philippines



Source: The International Atlas, Rand McNally and Company, 1981.

Map 3-2. Mineral Distribution in the Republic of the Philippines



Source: The International Atlas, Rand McNally and Company, 1981.
Area Handbook of the Philippines, Washington, D. C., 1976.

INTRODUCTION

The Republic of the Philippines is an island nation in the western Pacific consisting of over 7,000 islands with a total land area of 115,700 square miles. The two largest islands, Luzon and Mindanao, make up about 65 percent of the total land area. The present population is approximately 54.8 million people; common racial stock with minorities of Chinese, English, Spanish, and others. The literacy rate is about 85 percent with a heavy reliance on the private sector to provide secondary and higher education to the student population. The labor force is approximately 18 million.

The mining and extractive industries do not represent a significant part of the Philippine economy. In terms of gross national product, this industrial sector contributed only 2.6 percent of the total in 1982. From an employment aspect, mining represents 2 percent of the total work force. A large portion of the firms in the Philippines are government-owned or jointly owned by the government and foreign firms.

Table 3-1. Distribution of Labor in the Philippines

Industrial Sector	Percentage of Total Labor Force
Agriculture	36
Mining	2
Manufacturing	17
Construction	3
Transportation	4
Commerce	14
Services	24

Source: Area Handbook of the Philippines, Washington, D. C., 1982.

The development of the industrial base in the Philippines has been a struggle that has lasted over two decades. Over the entire period, government involvement in industry has been extensive, initiating programs, establishing incentives for investment, subsidizing activities, and revising tariff and customs codes. Many of these actions have been under the continued leadership of President Ferdinand E. Marcos, who was elected in 1965, re-elected in 1969, and assumed full power under martial law in 1972. The country is in the process of transferring from a presidential form of government, similar to a dictatorship, to a parliamentary form of government. The president has an extremely broad range of powers due to the absence of a formal national legislature. With the end of martial law in 1981, a moratorium on partisan politics and elections is presently drawing to a close, due to serious, widespread political protests that have reached gigantic proportions.[1]

GEOLOGY

The Philippine Islands can be considered as the crumpled edge of the Asiatic continental platform. The islands are mainly composed of the results of a huge volcanic chain. The principal groundmass consists of volcanic tuff, marble, diorite, amphiboles, and schists. Numerous porphyry deposits, lode deposits, and veins exist on most of the islands. Additionally, as a result of many years of weathering, placer deposits contain epigenetic concentrations of several types of

minerals.[2] The geology of each commodity is discussed in the mineral commodity analysis section of this chapter.

RESOURCE/RESERVE BASE

Due to the lack of physical infrastructure, which is discussed later, and the lack of funds to devote to the issue, the government of the Philippines has not completed geological surveys of the entire country. This effort is further hampered by the hostile jungle-like environment in the remote areas and the rugged, untamed landscape. Petroleum reserves in the Philippines were virtually non-existent until 1979 when exploitable reserves were discovered after years of exploration and drilling. Reserves were estimated to be 10 million barrels in 1980.[3] Natural gas reserves are insignificant, indicating that the Philippines' oil wells are not gas-producing. Coal reserves were estimated to be 150 million metric tons.[4] Non-fuel mineral reserves statistics are shown in Table 3-2 below.

GROSS NATIONAL PRODUCT

The Republic of the Philippines' gross national product in current dollars has steadily increased over the past twenty years, but at a relatively slow rate. The government continuously strives to increase the growth of the economy through rigorous domestic investments, concentrating on roads, bridges, and other infrastructure projects, financed largely through the World Bank. Low export earnings and continual devaluation of the Philippine peso, along with increasing trade deficits and a large external national debt, keeps the

economy from growing at a faster rate.[5] Table 3-3 below shows the trend of the gross national product and value of the mineral and mining industries in the Philippines in the past twenty years.

Table 3-2. Non-Fuel Mineral Reserves (Metric Tons)

Commodity	Ore Reserves	Percent Grade
Iron	1,150,000,000	47
Gold	5,634,976	.2-.5 T Oz/Ton
Silver	5,634,976	1.06-2 T Oz/Ton
Copper	22,585,615	1.42
Chromite	10,330,000	51
Manganese	350,850	32-43
Lead	804,299	2
Zinc	804,299	.967
Sulfur	1,450,000	40
Limestone	45,000,000	na
Phosphate Rock	160,000	10-30
Clay	10,000,000	na
Nickel	3,000,000,000	na
Salt	10,000,000	na
Gypsum	1,494,000	90
Feldspar	709,000	na
Aluminum	17,000,000	11

Source: Information Circular No. 16, Philippines Natural Resource Bureau.

NATIONAL DEBT

The Philippine Government has continually tried to bolster the economy through development and investment programs. Much of the capital has been obtained through borrowing. In 1982, the external national debt increased 30 percent to $17 billion, half of the annual gross national product.[6] This was caused largely by increasing problems in obtaining foreign exchange. Currently the international Monetary Fund has set a $2 billion annual credit limit on all foreign loans made to the Philippines.[6] This action will slow infrastructure and

industrial development, but will create a good climate for foreign firms wanting to invest in the Philippines.

Table 3-3. Philippines' Gross National Product (Millions of Dollars)

Year	GNP	Minerals and Mining	Percent of GNP
1963	$4,074	$110	2.7
1964	4,800	120	2.5
1965	4,867	146	3.0
1966	6,200	186	3.0
1967	6,300	214	3.4
1968	7,200	236	3.3
1969	8,509	314	4.0
1970	8,106	268	3.3
1971	8,633	313	3.6
1972	11,857	330	3.7
1973	13,031	526	5.4
1974	13,864	706	5.0
1975	15,700	542	3.5
1976	17,700	620	3.5
1977	20,700	720	3.5
1978	23,900	1,051	4.4
1979	29,200	963	3.3
1980	30,570	1,013	3.3
1981	32,070	1,062	3.3
1982	33,064	860	2.6

Source: Republic of the Philippines, Bureau of Mines, Manila.

ENERGY MIX

The Philippine Government is very actively striving to change the energy mix of the country. Programs are currently being pursued with a goal of energy self-sufficiency. The first nuclear power plant is being built by Westinghouse Electric Company and the Philippines National Power Company. It was 20 percent completed when the Three-Mile Island incident occurred in March of 1979. Construction ceased for revision of plant design, changing cost estimates from $1.1 billion to $1.9 billion. Completion date is set for December 1984, one

year behind schedule.[7]

With the demand and price of coconut oil falling, the Philippines have begun using it as a fuel in navy ships and in government vehicles. Nearly one-third of the Philippine population depends on a solid coconut oil market for their livelihood, and the price of coconut oil has fallen from 52.5 cents per pound to 28.5 cents. Eighty percent coconut oil and twenty percent diesel fuel is mixed together to form Cocohol or Cocodiesel. This mixture is necessary to keep the coconut oil from solidifying. The thermal efficiency is the same as for diesel fuel, but extensive filtration is required in fuel systems using it. This program could save over $45 million per year on reduced diesel fuel imports.[8]

By 1989, harnessed geothermal energy should generate 7.2 percent of the total electrical requirement in the Philippines, compared to 1.6 percent in 1979. The Philippine Government has earmarked $347 million for exploration and development of geothermal energy. By 1989, the present capacity of 446,000 kilowatts will be expanded to 1.26 million kilowatts.[9]

The present and planned energy mix in the Philippines is shown in Table 3-4 below.

WATER AVAILABILITY

Water in the Philippines is abundant with an average annual rainfall of 77.26 to 128.08 inches. The priority of use of water in the Philippines is (1) domestic uses including farming and livestock feeding and watering; (2) municipal use

including drinking water and sanitation; (3) irrigation uses for high-production farming and rice paddy flooding; (4) industrial uses including minerals processing; (5) electric power generation at hydroelectric stations; and (6) recreation such as swimming, fishing, and boating.[10] Very likely marine water encroachment will eventually result from overuse of water in the Philippines.

Table 3-4. Philippines' Energy Mix

Energy Source	Percentage of Total (1980)	Planned (1989)
Oil	22.5	6.2
Hydroelectric	6.3	12.8
Coal	0.3	6.3
Nuclear	0.0	3.5
Unconventional	0.0	1.9
Non-Power	69.2	62.2

Source: Oil and Gas Journal, March 2, 1981.

ENVIRONMENTAL CONSIDERATIONS

The Philippine Government is faced with the problem of solving five basic environmental problems: (1) industrial dumping of mine and mill tailings into local rivers and streams as a means of disposal; (2) uncontrolled deforestation by lumber and pulp companies having no replanting programs resulting in damaging soil erosion; (3) the discharging of highly mineralized acid mine waters into the drainage systems at many mine sites; (4) ground subsidence due to collapse of underground workings after abandonment of depleted mines; and (5) destruction of beaches from dredging operations.[11]

In an attempt to correct some of the tailings disposal problems, several large mineral processing corporations have

constructed elaborate pipeline systems with settling, sluicing, and separating stations, piping the tailings to the sea. Presently environmental studies are being conducted to determine the impact these pipelines have on the ocean water.[12]

In 1976, all magnetite beach sand mining was banned by the government because of a failure by the mining companies to protect the environment. Particularly affected by this action were iron sand mining companies that had contracts with Japan for iron concentrates, but the government insisted that the mining companies agree to rehabilitate and revegetate the beaches before mining can be resumed.[13]

Presently very little else is being done to eliminate environmental problems. More emphasis is being placed on development and expansion of existing operations, and money is not left over for environmental protection.[10]

INFRASTRUCTURE

The Philippines has relied on its numerous ports as the basis of its infrastructure development. Table 3-5 shows the principal sea ports capable of berthing ocean-going vessels in the Philippines. The capabilities of the Philippine ports are significant. Brazil, the largest exporter of iron ore in the western hemisphere, uses transshipping facilities at the Philippines to transfer huge quantities of iron ore to smaller ships for further shipment to other Asian countries.[14]

The only railroads in the Philippines are government-owned-and-operated, and are on the islands of Luzon, Panay, and

Cebu, as shown on the map on the first page of this chapter.

Table 3-5. Major Ports in the Philippines

Name of City	Island Located on
San Fernando	Luzon
Olongapo	Luzon
Manila	Luzon
Cavite	Luzon
Tacloban	Luzon
La Paz	Panay
Pulpandan	Negros
Cebu	Cebu
Zamboanga	Mindanao
Davao	Mindanao

Source: Atlas of the World, National Geographic Society, Washington, D. C., 1981.

The country basically lacks widespread infrastructure to support the movement of goods and services necessary to develop economically. The major islands have a developed road system connecting most cities of 20,000 people or more, but most other roads are not hard-surfaced, but are surfaced only with earth and gravel.[1]

The Philippines has a good international air communications network and domestic service. See Table 3-6 for airfield locations.

MINING, PROCESSING, AND REFINING

The Philippines' methods of mining and processing minerals are modern and sophisticated. Open pit mining, block cave mining, and dredging are the primary methods of extracting ore. Great care is taken in the Philippines to take advantage of by-product and coproduct relationships when processing ore. This is particularly significant in the porphyry belt where grades

are low, and without taking advantage of byproducts, mineral processing from these deposits would not be economical.

Table 3-6. Airfields in the Philippines

City	Island Located on
Laoag	Luzon
Angeles	Luzon
Olongapo	Luzon
Quezon	Luzon
Pasay	Luzon
Manila	Luzon
Trece Martires	Luzon
Cavite	Luzon
Malolos	Luzon
Palo	Samar
Cebu	Cebu
La Paz	Negros
Bacoloa	Mindanao
Davao	Mindanao
Baliwasan	Mindanao

Source: Atlas of the World, National Geographic Society, Washington, D. C., 1981.

Processing minerals in the Philippines includes several methods such as flash smelting, combined roasting and smelting, primary and secondary crushing, gravity settling, flotation, and others. The Philippines has also led the development of nickel processing by operating the world's first plant that processes pure refined nickel directly from nickel laterite, using the Sherritt-Gordon Process.[16] The government of the Philippines has continually stressed downstream processing of minerals and, during the past 10 years, significant progress has been made. Integrated mineral complexes to extract byproduct minerals are in operation and many minerals are concentrated and smelted prior to export.[12] As stated earlier, progress in this area is severely hampered by the huge national

debt and the inability to obtain capital. Specific processing and refining is discussed with the commodities later in this chapter.

INTERNATIONAL TRADE

The Philippines has traditionally been a major agricultural and forestry products exporter, being a major exporter of sugar, forest products, copper, copra, coconut, coconut oil, and abaca. In the past decade, markets and prices of these products have been declining, especially for the agricultural products. As a result of this, the Philippines has begun shifting efforts toward other exports. The government has recently initiated massive programs to promote non-traditional exports, and a goal to reduce the annual trade deficit from $1.5 billion to $75 million has been established.[3] The principal export markets for the Philippines are the United States, Japan, the Netherlands, and the Federal Republic of Germany. For a detailed look at mineral commodities exports and trading partners in 1981, see Table 3-7.

The chief imports in the Philippines are machinery, base metals, fuel minerals, transport equipment, and food. The principal import sources are the United States, Japan, the Federal Republic of Germany, Australia, and Saudi Arabia. For principal mineral commodities imported and trading partners in 1981, see Table 3-8.

Table 3-7. Principal Mineral Exports, 1981
(Metric Tons)

Metals	Quantity	Trading Partner(s)
Aluminum	2,879	Indonesia Hong Kong Singapore
Chromium Ore and Concentrate	397,382	United States Japan Sweden China
Copper Ore	1,130,000	Japan China
Iron and Steel	93,343	Hong Kong Japan Indonesia
Lead Ore and Concentrate	1,801	Japan
Manganese	2,800	Japan
Nickel Ore and Concentrate	575,443	Japan Netherlands North Korea
Silver (Troy Ounces)	26,900	United States Japan Republic of Korea
Zinc	11,873	Japan
Non-Metals	**Quantity**	**Trading Partner(s)**
Cement	492,734	Indonesia Hong Kong India
Stone, Sand, and Gravel	69,317	Japan Hong Kong Guam
Mineral Fuels	**Quantity**	**Trading Partner(s)**
Coal	6,800	Japan
Petroleum (Barrels)	1,165,842	Thailand Bahamas Hong Kong Australia Japan Bermuda

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

Table 3-8. Principal Mineral Imports, 1981
(Metric Tons)

Metals	Quantity	Trading Partner(s)
Aluminum	29,060	Malaysia
		Australia
		France
Copper	9,671	Japan
Iron and Steel	838,910	Japan
		China
		Australia
Lead	7,311	Australia
		Peru
Manganese	3,315	Singapore
Mercury (Value)	$72,000	Japan
		France
Tin	6,339	Japan
		Australia
		Canada

Non-Metals	Quantity	Trading Partner(s)
Asbestos	5,499	Canada
Cement	11,381	Japan
Clays	1,311,527	United States
		Japan
		United Kingdom
Fertilizers	647,365	United States
		Kuwait
		Indonesia
		Quatar
Gypsum	75,596	Japan
		Australia
Salt	44,679	Australia
		Mexico
Stone, Sand, and Gravel	31,537	Malaysia

Mineral Fuels	Quantity	Trading Partner(s)
Coal	228,139	Japan
		United States
Petroleum (Barrels)	61,206,000	Saudi Arabia
		Kuwait
		Indonesia
		China

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

MINERAL COMMODITY ANALYSIS

The next few sections of this chapter expound on the imports, production, and exports, development, trends, and potential of the important minerals in the Philippines. The Republic of the Philippines is highly dependent upon energy, metals, and non-metal minerals imports. Table 3-9 shows at a glance the import-dependence position of the Philippines for many of the non-fuel minerals.

ENERGY MINERALS

PETROLEUM

The petroleum industry in the Philippines is in the infant stages, but only from a crude oil standpoint. Over 275 wells had been drilled by 1972, and none were economically exploitable. The first producing well was drilled in 1976, with significant production beginning in 1979.[5] Until 1979, the Republic of the Philippines was 94 percent import-dependent for crude oil, nearly all of it coming from the Middle East, particularly Kuwait.[5] Philippine imports of petroleum increased dramatically in 1966 as a result of increased oil refinery capacity, but leveled off due to the recent domestic production of crude oil.[5]

Table 3-9. Commodity Imports, Exports, Production, and Import Dependence (Units are in Metric Tons Unless Otherwise Specified).

Commodity	Imports	Production	Exports	Import Dependence
Aluminum	32,500	0	2,963	100
Chromium	585	496,060	484,109	0
Cobalt	1	1,331	0	0
Copper	10,057	304,504	1,157,500	0
Gold (Troy Ounces)	0	643,806	367,211	0
Iron and Steel	5,592,000	442,647	423,200	92
Lead	6,494	0	4,126	100
Magnesium	18	0	0	100
Manganese	7,991	0	0	100
Molybdenum	17	0	210	20
Nickel	190	72,495	150,936	0
Platinum and PGM	101	0	0	100
Silver (1000 Troy Ounces)	0	1,952	29,769	0
Tin	553	0	34	100
Titanium	1,322	0	0	100
Tungsten	96	0	393	25
Zinc	16,987	6,845	15,143	5
Zirconium	383	0	0	100
Asbestos	4,467	6	0	100
Barite	1,893	5,355	0	35
Boron	839	0	0	100
Cement (1000 Tons)	29	4,482	767	1
Clays	35,300	505,457	641	7
Diamonds	4	0	0	100
Feldspar/Fluorspar	3,022	15,925	0	19
Fertilizers	1,091,000	58,380	1,552	95
Graphite	184	0	0	100
Gypsum	65,671	110,000	0	59
Lime/Limestone	758	87,363	0	1
Salt	60,022	346,387	0	17
Sand, Stone, and Gravel (1000 Metric Tons)	29	24,499	129	0
Sulfur	99,455	53,589	54	65
Talc	8,097	863	0	89

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

Crude oil production in the Philippines is currently from three oilfields with the following daily production: Nido Oilfield, 2,000 barrels; Cadlao Oilfield, 5,000 barrels; and Matinloc Oilfield, 9,000 barrels. This production was higher earlier in 1982, but technical problems and water intrusion has caused it to decline.[5] Due to the offshore nature of the oilfields in the Philippines, and the overall geographical location of the country, production of crude oil is frequently interrupted because of damage to production equipment caused by stormy weather and high seas.[17] The Philippines operates four large oil refineries with a total capacity of 180,000 barrels per day. These refineries are owned by Caltex (Philippines), Inc., ESSO Standard Philippines, Shell Company of the Philippines Ltd., and Filoil Refinery Corporation.[5]

Figure 3-1 shows the production, imports, and exports of petroleum in the Philippines. It must be pointed out that over 90 percent of the quantity represented by the production curve is refinery production from imported crude oil. Exploration for oil is at reduced levels due to the present worldwide oil surplus and budget cuts made by the government. There were only 17 wells scheduled by the Philippines Bureau of Energy Development for drilling in 1983, compared to an average of 30 wells per year in recent years.[17]

NATURAL GAS

Natural gas in the Philippines is an insignificant source of energy. The oil wells, thus far, are not gas-

producing and the national energy plan does not forecast any change from the present situation. Because of the capital-intensiveness of transporting, storing, and distributing natural gas, the government does not plan to import natural gas.

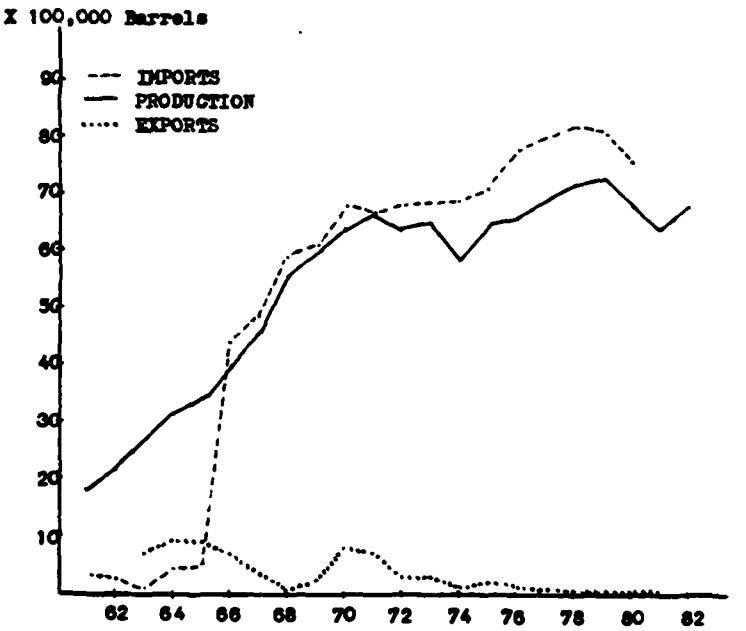


Figure 3-1: Annual Imports, Production, and Exports of Petroleum in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

COAL

The Philippines produces coal from proven reserves totalling 233 million tons at the end of 1982.[17] Two coal deposits on the island of Semirara contain 75.8 million tons and the rest is in smaller scattered deposits on the islands of Cebu and Mindanao. The coal deposits are in steeply inclined layers, sometimes completely vertical. They are highly faulted and difficult to mine. Seam thicknesses are up to two

meters thick, but some are 0.6 to 1.6 meters thick. Igneous intrusions and the old age of the coal are also factors affecting production, making many seams economically unattractive. Coal production and imports were relatively low until in the mid-1970's when oil began to increase drastically in price. Production declined during the 1960's because of declining demand.[5] Beginning in 1975, coal production increased rapidly to accomplish the energy mix goals established by the government as previously discussed. Figure 3-2 shows production and imports of coal in the Philippines. Because of the continuing drive for energy self-sufficiency, imports have been reduced and production has increased. Production increased 84 percent in 1982, but even at this level, coal output was only 50 percent of total capacity, and only 40 percent of the government's goal.[17] All Coal, both bitunimous and anthracite, is produced by two major coal companies in the Philippines; Semirara Coal Corp. and the Philippines National Oil-Coal Corp. Presently the government is promoting a $25 million coal exploration program financed by the World Bank ($17 million) and by the Philippine National Oil Company ($8 million).[17]

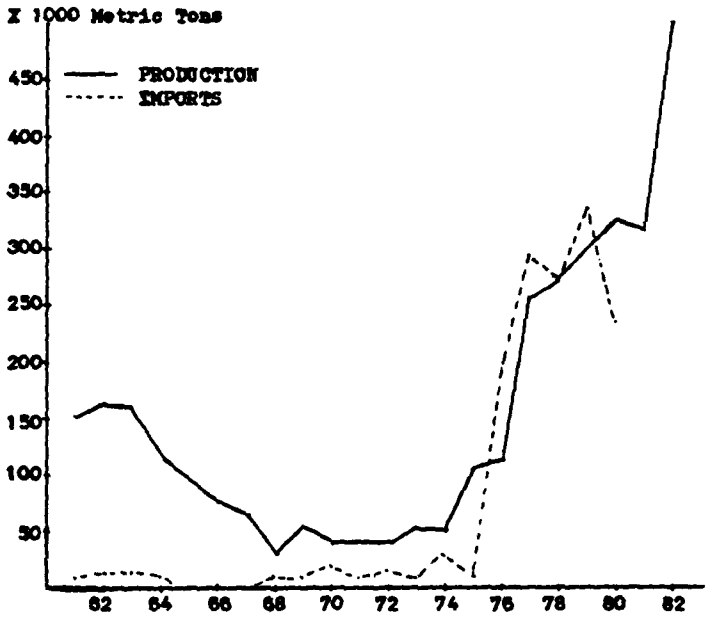


Figure 3-2: Annual Coal Production and Imports in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

METALLIC MINERALS

ALUMINUM

The Republic of the Philippines is totally dependent upon imported aluminum ore and metal, with most of the imports in the form of ore and concentrates. The Philippines exports finished aluminum to Hong Kong, Indonesia, and Singapore. These exports are largely the result of an aluminum smelter built by Reynolds Metal Company and the Republic Flour Mills with a capacity of 60,000 tons per year. Another smelter planned to be constructed by 1983 is not progressing well due to the Philippines' debt situation, despite assurances that Reynolds Aluminum Company would finance and build the smelter.[18]

Recent exploration by the Philippines Bureau of Mines

and Geosciences in 1981 has revealed that bauxite deposits of approximately 120 million metric tons exist on the Samar and Batag Islands, but due to deteriorated civil conditions and the large national debt, development of these deposits will not commence for some years.[18] Figure 3-3 shows imports and exports of aluminum in the Philippines from 1961-1982.

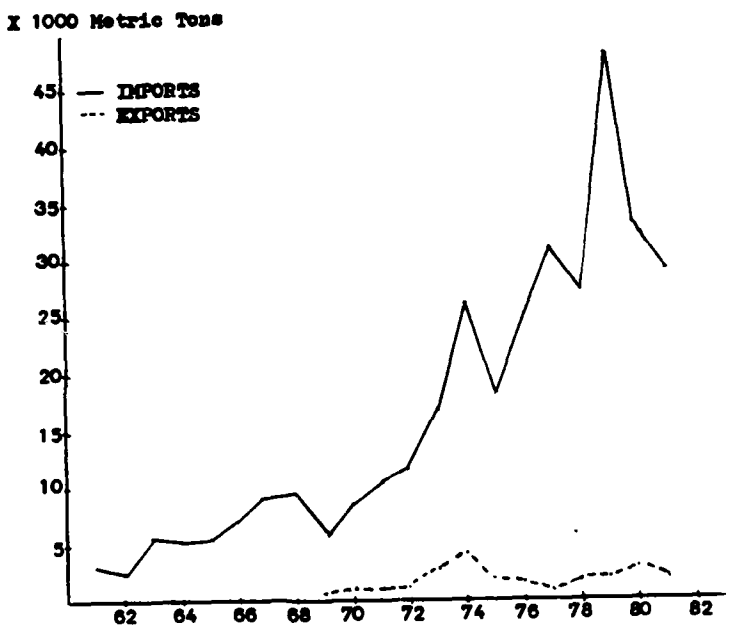


Figure 3-3: Annual Imports and Exports of Aluminum in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

CHROMIUM

Chromium is one of the Philippines' most important commodities in terms of production and exports. Chromite is found in the western cordillera mountains of Panay and is associated with mafic and ultramafic rocks such as serpentine, peridotites, and amphiboles. The deposits are the alpine-type ultramafic intrusion deposits, forming non-layered, pod-like ore

bodies of high grade chromite.[2] The Philippines began importing oxides and hydroxides from the United Kingdom and Japan in 1972.[5] In 1979, large quantities of ore and concentrate were imported from West Germany, primarily because of declining production resulting from a typhoon damaging mines and infrastructure.[13]

Production of both metallurgical and refractory grade chromium has been dominated by Consolidated Mines, Inc., accounting for 87 percent of refractory grades, and by Acoje Mining Company, producing 88 percent of metallurgical grades. Mining methods range from open pit to underground mining, and is concentrated on the island of Palawan. Production is affected by weather, particularly high seas and heavy rainfall.[5] Production, import, and export trends are shown in Figure 3-4.

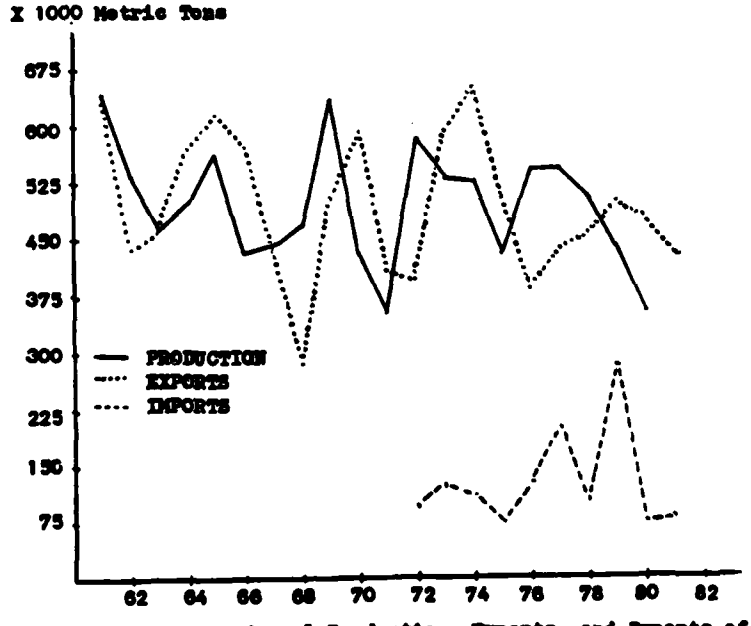


Figure 3-4: Annual Production, Exports, and Imports of Chromium in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

COBALT

Cobaltite is found in the Philippines in hydrothermal veins and cobalt-nickel sulfides.[2] Cobalt production began in 1975 and has been expanded rapidly to take advantage of increasingly higher prices.[12] The Philippines remains one of the top six world cobalt producers. However, the production level of the Marinduque Mining and Industrial Corporation, the only major cobalt producer in the country, has been declining since 1980. This is largely due to the coproduct relationship of cobalt and nickel in the form of nickel-cobalt mixed sulfides in the Philippines. The cutback of output of nickel concentrate and refining operations on Nonoc Island, because of weakened nickel prices in the world market, has had a drastic effect on cobalt production.

Cobalt, being principally used in high technology military equipment and in electronics, is a very young industry in terms of production and trade in the Philippines. In 1978, Marinduque wanted to construct a $16 million cobalt refinery which would give the Philippines the capability of being second only to Zaire in terms of world production, but the National Economic and Development Authority dissapproved the project.[19] As a result, all nickel-cobalt sulfide is shipped to Japan for refining after initial processing. The trends of cobalt production and imports in the Philippines are shown in Figure 3-5. Data concerning the exports of cobalt from the Philippines is not directly available, possibly due to the sensitivity of the cobalt market.

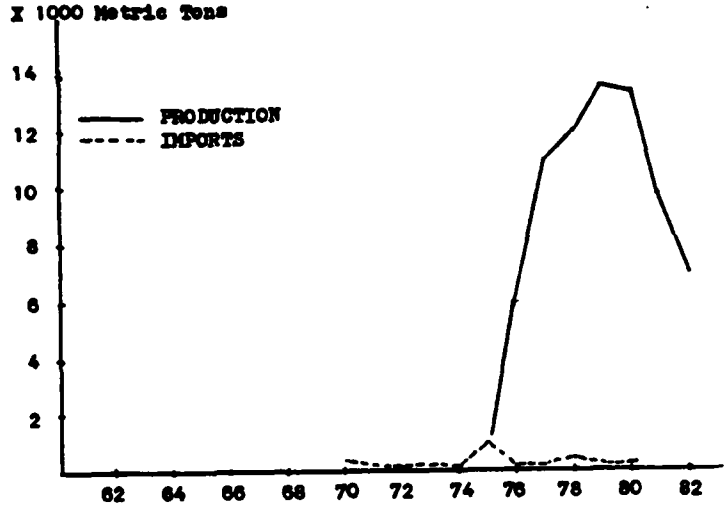


Figure 3-5: Annual Production and Imports of Cobalt in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

TUNGSTEN

Republic of the Philippines is 100 percent import-dependent for supplies of tungsten. Since tungsten is primarily used for military equipment, light bulbs, and electrical circuitry, it has been unimportant to the Philippines until in the 1970's and, even then, on a very small scale. Except for 1980, when the Philippines imported 96 tons, from the United States and Japan, the average imports of tungsten are only 2 to 4 tons per year. No information for the large imports in 1980 is given, but the size of this one-time import increase is not significant in world terms. Figure 3-6 shows the annual imports of tungsten in the Philippines.

SILVER

Silver production in the Philippines is derived as a byproduct of copper and gold, and is of minor importance as a

primary precious metal. Silver is found on nearly every island in nearly every stream as an alloy metal in gold placer deposits. It also occurs in igneous and metamorphic rocks as an alloy of gold-bearing quartz and calcite veins.[2] The level of production of silver is due to the steady demand of its co-products.

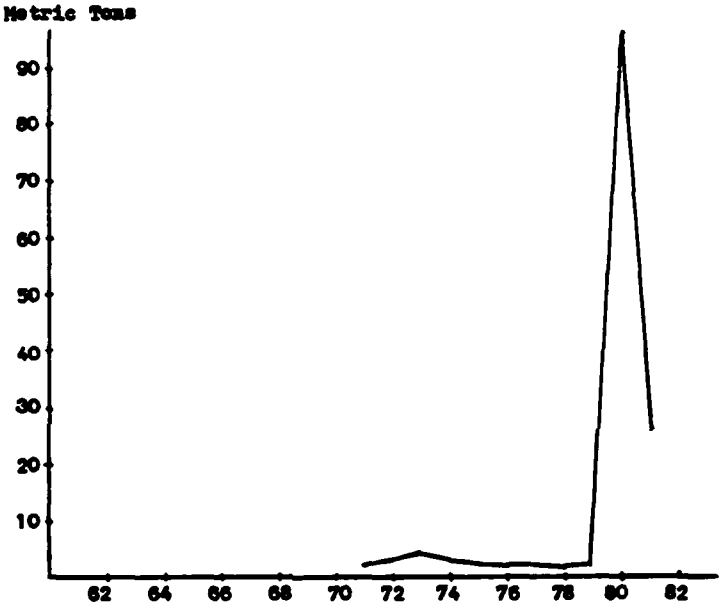


Figure 3-6: Annual Tungsten Imports in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Figure 3-7 shows annual silver production and trade in the Philippines. Note that in the mid-1970's, the production declined nearly 25 percent due to an oversupply of copper in the world, reducing the silver byproduct output during this period of lower copper output. The major producing companies, in order of importance, are Lepanto Consolidated, Marinduque Mining and Industrial Corp., and Benguet Consolidated.[5]

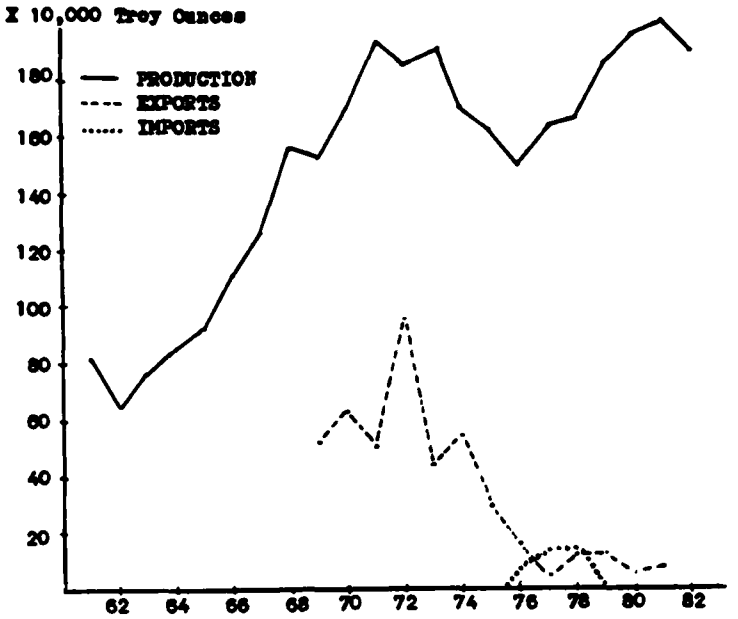


Figure 3-7: Annual Production, Imports, and Exports of Silver in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

COPPER

The Philippine Islands contain a porphyry copper-gold belt that is extensive and includes the Basay Deposit containing 250 million tons of 0.4 percent copper with molybdenum, gold, and silver; the San Antonio Deposit containing 200 million tons of 0.42 percent copper with gold; the Lobo Deposit with 90 million tons of 0.34 percent copper with gold; the Taipan Deposit with 90 million tons of 0.58 percent copper; and a number of smaller deposits. Proven reserves total 3 billion tons with an average grade of 0.4 percent copper, and indicated reserves represent another billion tons of ore, all with gold as an important byproduct.[12]

Copper has been, is, and probably will be the most

important mineral commodity in the Philippines. The Philippines has remained one of the top 10 copper producers in the world for a number of years, but the most recent trends indicate that this may change. Production dropped in 1981, and 1982 proved to be the worst year, economically since 1978. Much of this production decline is attributed to a substantial reduction in world copper prices and increased production costs.[12] Copper is mined from open pit and block cave mines with modern equipment. Primary crushing is done at the mine site and secondary crushing is done in more centralized locations. The copper ore is concentrated using flotation methods, and flash smelting is accomplished with oxygen-enrichment to increase smelter capacity. The Philippines use the Outokumpu Oy Flash Smelting Process, which combines roasting and smelting in three-stage furnaces and promotes downstream processing of byproducts and gases.[13]

In an effort to subsidize the copper industry, the government of the Philippines established a copper stabilization fund in July 1982, and when prices fell below 60 cents per pound, President Marcos ordered the National Development Corporation to rescue the copper producers. The government has been paying the difference between current prices and 75 cents per pound since 1982. The prospects of price rises were bleak, and with massive deficits and a huge external national debt, the government could not afford to pay out millions of dollars each year as copper subsidies.[20] However, most recently, in mid-1984, copper prices improved to the point where

subsidies could be reduced.

The Philippines import small amounts of copper metal, mostly from Japan, in an effort to maintain a more favorable trade balance with Japan. Exports of copper metal have not been significant, except in 1980, when Japan imported over 7000 metric tons of copper matte and scrap from the Philippines. Figure 3-8 shows the import and export trends of copper metal in the Philippines.

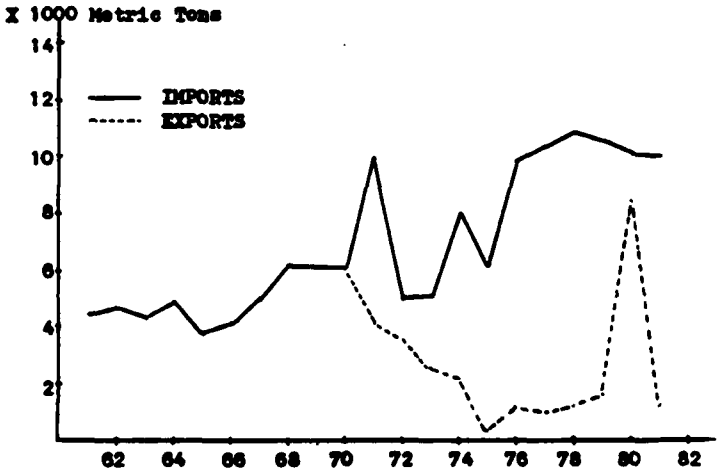


Figure 3-8: Annual Imports and Exports of Copper Metal in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

A large portion of the copper ore produced in the Philippines is exported for processing and refining elsewhere. The Philippine Government would like to process more copper locally, but cannot obtain the capital necessary to increase refinery capacity.[21] Japan is the leading importer of Philippine copper ore and concentrate, followed by the Republic of Korea.[5] Additionally, Brazil signed a long-term contract in

1977, to purchase over 2,000,000 tons of copper concentrate over the next 10 years, as a political move to establish the transshipping port facility discussed earlier.[13] Figure 3-9 shows the export trends of copper ore and production of copper metal in the Philippines.

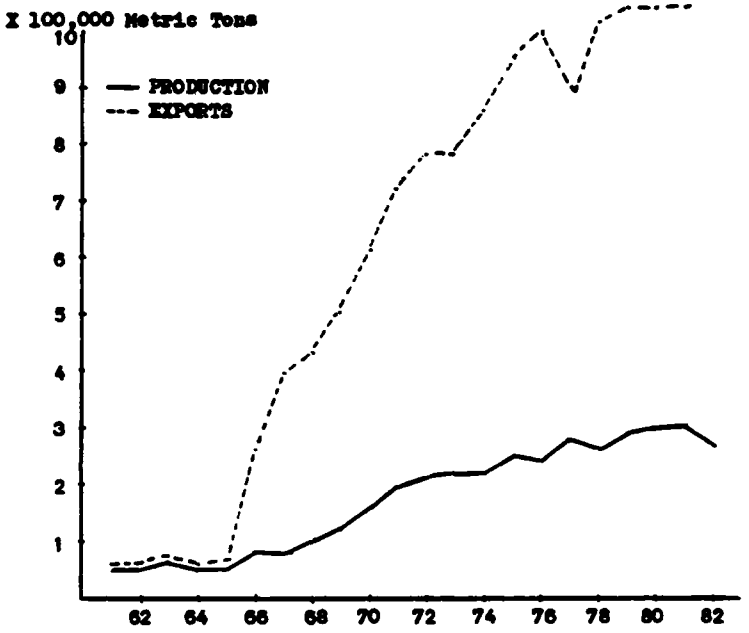


Figure 3-9: Annual Copper Metal Production and Copper Ore Exports in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GOLD

Gold production in the Philippines has been steadily increasing, and a significant portion of the gold produced is as a byproduct of copper mining.[2] The Philippines has six primary gold mines and fourteen lesser mines, which, until recent years, were subsidized at times to maintain operations. With world prices up significantly since 1977, the gold industry in

the Philippines is thriving, and many old mines that were previously closed are re-opening.[22] There are seven major gold producing firms in the Philippines; Benguet Consolidated, Inc., Lepanto Consolidated Mining Co., Itogan-Suyoc Mines, Inc., Philex Mining Corp., Benguet Exploration, Inc., Gumaus Consolidated Mining Co., and Bajuio Gold Mining Co. 1982 was a record year for production with the Philippines reporting production of over 793,000 troy ounces.[17] The Philippines is an exporter of gold. The principal market for Philippine gold includes Japan, the United States, the United Kingdom, and China.[5] Figure 3-10 shows production and exports of gold in the Philippines. The reduction of production in the mid-1970's is a result of depressed copper production and the depletion of some gold deposits.[23]

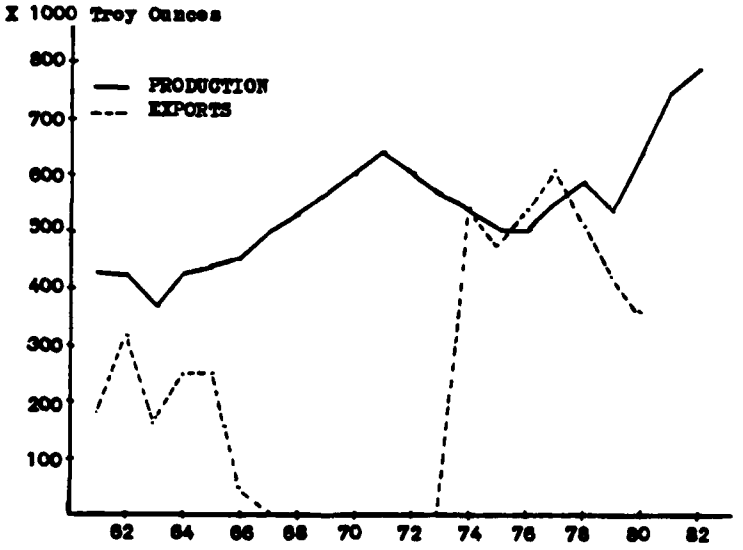


Figure 3-10: Annual Production and Exports of Gold in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

IRON AND STEEL

The Philippines can be considered rich in terms of its reserves of iron ore, with reported reserves of over a billion tons of high grade iron ore. Much of these reserves are in the form of magnetite beach sands.[2] Fine-grained hematite and magnetite, associated with contacts between igneous and sedimentary rocks are also found. Massive pyrite and chalcopyrite occurs as veinlets with some cobalt throughout the islands. As a result of these reserves, improvement and expansion of the nation's steel industry has been a goal of the Philippine Government for quite a few years, and the government has been quite successful at achieving this goal.[5]

The Philippines has consistently imported a considerable amount of iron and steel, mostly pig iron, primary steel, and steel plates, because although the industry is booming, domestic demands exceed production. Figure 3-11 shows the production and imports of iron and steel in the Philippines.

Production of iron and steel in the Philippines has grown slowly in the past two decades. The major producing companies include the San Phi Quinto Mining Co., the Construction Aggregate Producers Co., Iligan Integrated Steel Mills, Inc., Santa Inez Steel Corp., Black Mountain, Inc., Elizalae Iron and Steel Corp., and the Philippine Iron Mines. Total capacity in 1965 was 1,130,000 metric tons per year. In 1982, capacity was six times that size, with the Philippine Sinter Corp., a wholly-owned subsidiary of Japan's Kawasaki Steel Corp., operating Southeast Asia's largest iron sintering plant

on Mindanao Island, with a five million-ton-per-year capacity, a port, and a huge ore yard. This plant was commissioned in 1977, and has produced up to 4.5 million tons of fluxed sinter in a single year.[5]

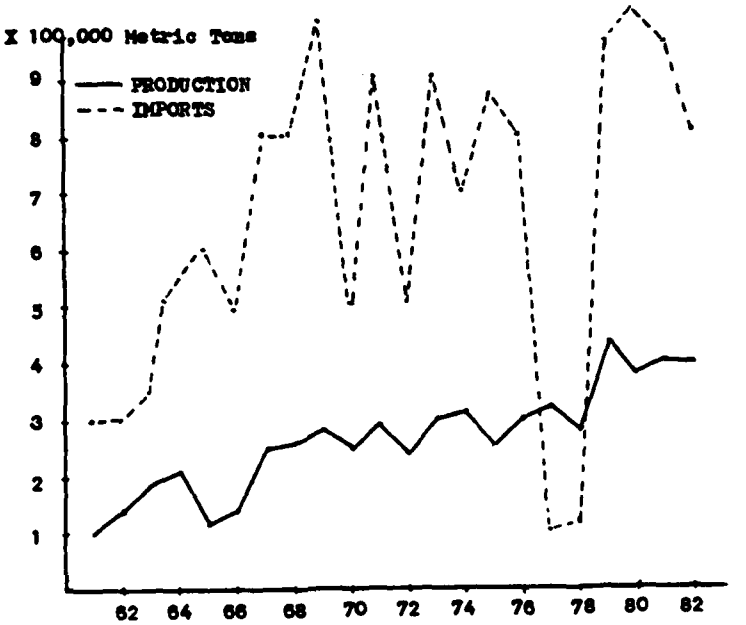


Figure 3-11: Annual Production and Imports of Iron and Steel in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Production of iron ore was increasing rapidly with the extraction of magnetite from beach sands dominating the other sources of supply beginning in 1968. In 1975, the government banned all beach sand mining for environmental reasons, as previously discussed. As a result, iron mining companies began importing iron ore, mainly from Australia, Brazil, and Canada, because production of domestic iron ore declined to almost zero in 1975, but since then, they have increased again, but are now in the form of roasted pyrite, being shipped to Japan for processing and refining.[5] The large-scale imports of iron ore are

necessary to feed the huge sinter plant on Mindanao. This complex also requires 480,000 tons of limestone per year as flux, which is produced domestically on the island of Bohol. Figure 3-12 shows the annual production, imports, and exports of iron ore in the Philippines.

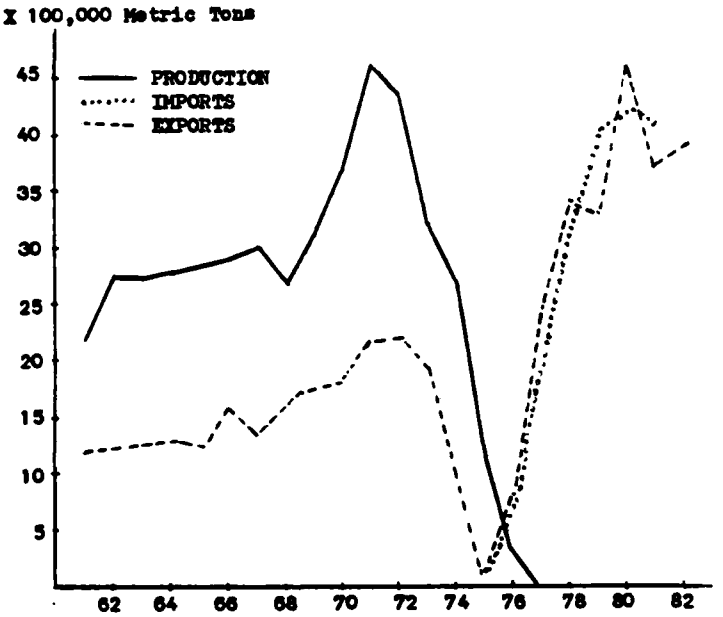


Figure 3-12: Annual Production, Imports, and Exports of Iron Ore in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

The Philippine's steel industry is becoming more integrated with several huge contracts beginning in 1982 and 1983. A Japanese consortium of Marubeni, Kawasaki Heavy Industries Ltd., Kobe Steel Ltd., and Ube Industries Ltd., has a $375 million contract to construct a direct reduction plant, a pelletizing plant, and a limestone calcination kiln for a 1.4 million-ton-per-year steel mill in Iligan City of Mindanao Island. Six 230,000 ton-per-year direct reduction plants reportedly will

be provided by Kawasaki, an iron ore pelletizing plant by Kobe, and a sintering plant by Ube. Japan is expected to obtain trade credit for this venture.[17] As part of this expansion program, the Philippines will purchase $43 million worth of steelmaking equipment including electric arc furnaces and a continuous casting system from Davy McKee of Great Britain, with British Government aid.[17]

LEAD AND ZINC

Lead and zinc occur in quartz veins of gelena and sphalerite in the Philippines. Some veins have been known to contain up to 60 percent lead and others up to 40 percent zinc. Silver is a byproduct of lead and normally occurs as argentite. Some associated veins also contain as much as 2 to 3 percent copper.[2]

The demand for lead has been rising steadily, forcing imports to rise to meet these demands. The lead imports were mainly from the United States and Australia until the late 1970's, but currently the Philippines imports lead oxides from Australia, Japan, and the United States. Lead scrap, unwrought, and semimanufactures are imported from Australia, the United States, and Peru. Annual production, imports, and exports are shown in Figure 3-13.

Zambales Base Metals, Inc. produces all of the Philippines' output of lead, and exports exclusively to Japan. In 1977, Zambales produced over 6300 tons of lead concentrate from mines having reserves of 4 to 5 percent combined lead and zinc

ores that can support increased output for more than a decade. However, mine output of lead in the Philippines did not increase, but has substantially decreased since 1977.[24]

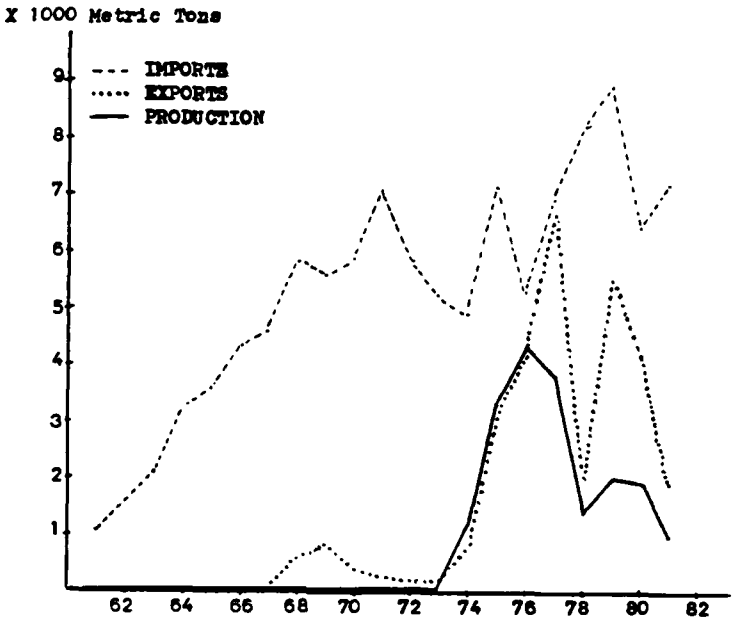


Figure 3-13: Lead Imports, Exports, and Production in the Republic of the Philippines Annually, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Zinc is a relatively minor mineral in the Philippines. Twice as much zinc is imported as is produced. Most imports are in the form of unwrought zinc metal.[5] Zinc production is relatively small, nearly all produced by Benguet Exploration, Inc., a company that is better known for its gold and silver production, and by Zambales Base Metals, Inc., both operating mines on the island of Mindanao.[17] Zinc ore and concentrate exports from the Philippines are all destined for Japan. Figure 3-14 shows the annual production, imports, and exports of zinc in the Republic of the Philippines.

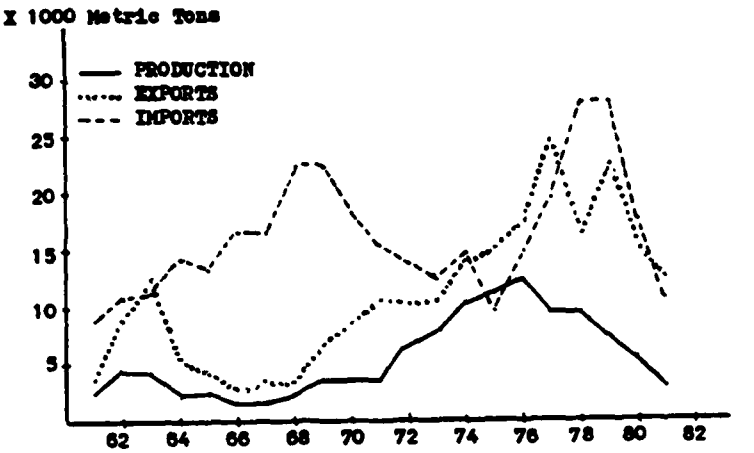


Figure 3-14: Annual Production, Imports, and Exports of Zinc in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

MANGANESE

Minor amounts of manganese, as psilomelane and pyrolusite, occur as replacement deposits in quartz and calcite veins. Most of these deposits are near pyrite veins associated with massive sulfide deposits.[2]

The Philippines, for all practical purposes, is 100 percent import-dependent for manganese supplies. This fact is significant in light of the steel integration plans the government has. Manganese imports were not required in the 1960's because of high levels of domestic production, but after 1968, production fell nearly 50 percent per year for 3 years in a row. Presently, unwashed manganese ore is produced by Black Mountain Mining Corporation on Isebela Island and by Associated Mining and Industrial Corporation on Agusan del Norte Island. The decline in production immediately triggered a dramatic increase in imports of manganese, all as ferromanganese.[17] The

primary source of imported manganese is Singapore. Figure 3-15 shows the sudden change and erratic behavior of manganese production, imports, and exports in the Philippines.

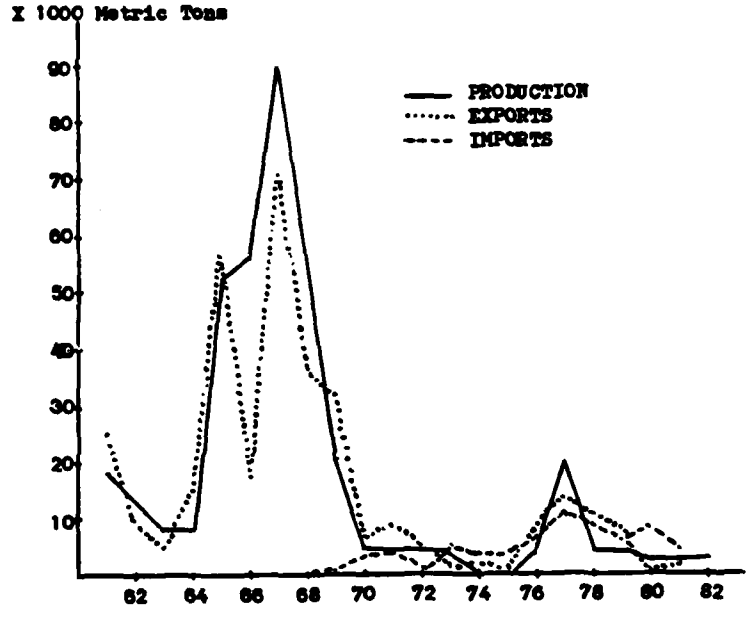


Figure 3-15: Annual Production, Exports, and Imports of Manganese in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

The recent decline in the past four years is due to problems in the iron ore mining industry in the Philippines, leading to inefficiencies in the steel industry and causing depressed manganese consumption.[5] All of the exports of manganese are in the form of ore and concentrate and are shipped to Japan.

MOLYBDENUM

Molybdenite occurs in the Philippines as a byproduct of porphyry copper deposits.[2] The only economical deposit is the

Basay Deposit, assaying .01 to .0125 percent molybdenite.[13] There are four byproduct molybdenum producers in the Philippines, but Marinduque Mining and Industrial Corp. and Black Mountain Mining Co. account for over 95 percent of all production. Molybdenum production and exports declined in the 1960's because of depletion of primary molybdenum deposits and due to depressed copper production. Then in the mid-1970's, when world copper prices were depressed, copper production was stunted and molybdenum production as a byproduct was suspended. The government began to subsidize copper in the late 1970's, and as a result, molybdenum production was resumed.[5]

Beginning in 1972, the Philippines imported molybdenum from the United States for re-export. This was done to obtain foreign currency because the price of molybdenum was rising and a profit was made as a result. Production is presently increasing due to improved recovery rates and higher prices.[12] Annual production, imports, and exports of molybdenum are shown in Figure 3-16.

NICKEL

Nickel occurs in the Philippines as nickel laterite and contains 1.14 percent nickel, 0.11 percent cobalt, and 45.1 percent iron ore.[28] Nickel production and trade became prominent in the Philippines beginning in 1970. Benguet Consolidated, Inc., a 90 percent U. S.-owned corporation, and MacArthur International Mineral Co. were competing to obtain leases on fast-growing reserves on Mindanao Island in the 1960's.[25] In 1968,

the nickel prospects looked so good that Marinduque Mining and Industrial Corp. and Sherritt Gordon Mines Ltd. joined the industry.[26] In 1970, the Philippines became a world leader in nickel production and reported over 3 billion tons of reserves.[27] Acoje Mining Co., Atlas Consolidated, and Benguet Exploration, Inc. began to get involved in the nickel industry in 1971.[5] By 1975, nickel had the potential of replacing copper as the number one foreign exchange earner in the country. In the late 1970's, the nickel industry was considered a priority investment by the Philippine Government, which granted tax incentives including free imports of capital equipment, deductions for organizational and operational expenses, and accelerated depreciation schedules.

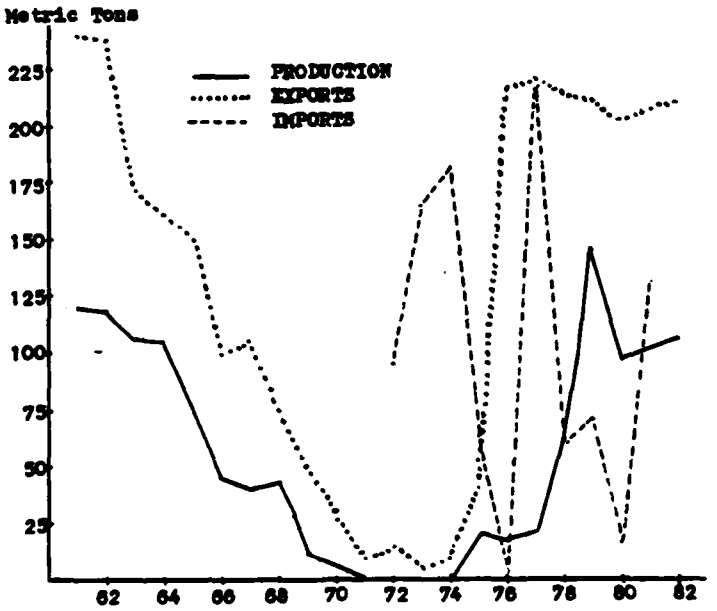


Figure 3-16: Annual Production, Imports, and Exports of Molybdenum in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Nickel prices were rising on the world market, and like the Philippines, other countries were increasing their production to take advantage of the situation. Supply exceeded demand, probably more due to the worldwide recession than to overproduction, and prices began to decline. As a result, production of nickel in the Philippines is presently on the decline.[30]

The Philippines refines nickel on a large scale on Nonoc Island and on Palawan Island, each refinery having a capacity of 34,000 metric tons of metal production per year. As a means of obtaining foreign exchange, the Philippines imports nickel ore and concentrate from Canada, Hong Kong, and Japan for further processing and refining.[5] Nickel processing is accomplished using the Sherritt-Gordon process, a relatively confidential process which yields a good recovery rate and promotes cobalt byproduct extraction.[16] In an effort to reduce production costs, Marinduque Mining and Industrial Corp. is converting its nickel-refining operations on Nonoc Island from oil to coal. This is expected to save over $50 million and cut the oil consumption at the refinery by 75 percent. Other companies may follow suit if it is successful.[18]

Nickel exports, shipped to Japan, are ore and concentrates, but unwrought nickel briquettes and semimanufactures are shipped to the United States, the Netherlands, Japan, and the Republic of Korea.[17] Figure 3-17 shows nickel imports, production, and exports in the Philippines.

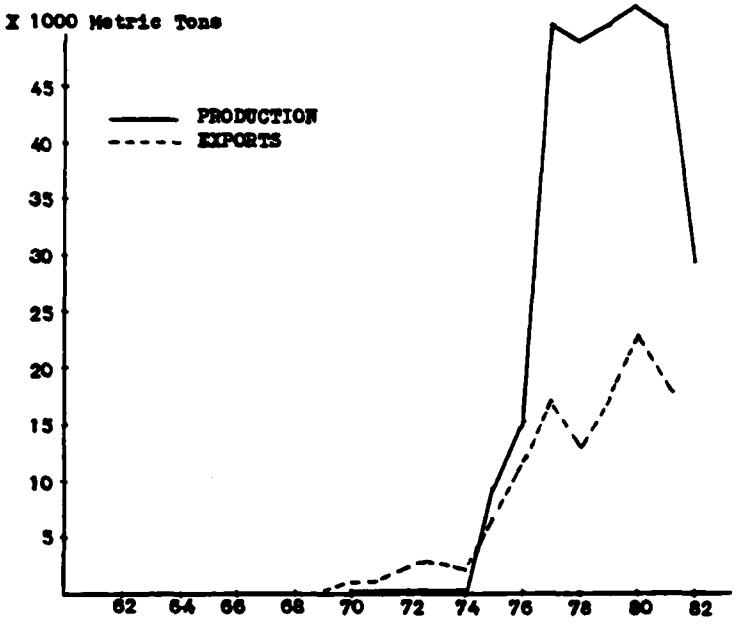


Figure 3-17: Annual Nickel Metal Production and Nickel Metal Exports in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

MERCURY

The Philippines produced and exported a substantial amount of mercury in the 1960's and 1970's. World demand and prices were high and encouraged production. The only producer in the Philippines was Palawan Quicksilver Mines, Inc. Reserves were estimated at 822,000 tons of 13 percent mercury.[9] In 1970, Palawan Quicksilver reported record production of over 5800 76-pound flasks, operating kilns with a 81.75 percent recovery rate, in a 300 tons-per-day capacity beneficiation plant.[27] In 1972, demand and production dropped 33 percent. In 1974, they declined 62 percent. Price was also declining rapidly. In 1976, the Philippines shut down all mercury production operations.[31] Declining demand, dramatic price

decreases, and substitutions made mercury production unprofitable. Figure 3-18 shows production, imports, and exports of mercury in the Philippines.

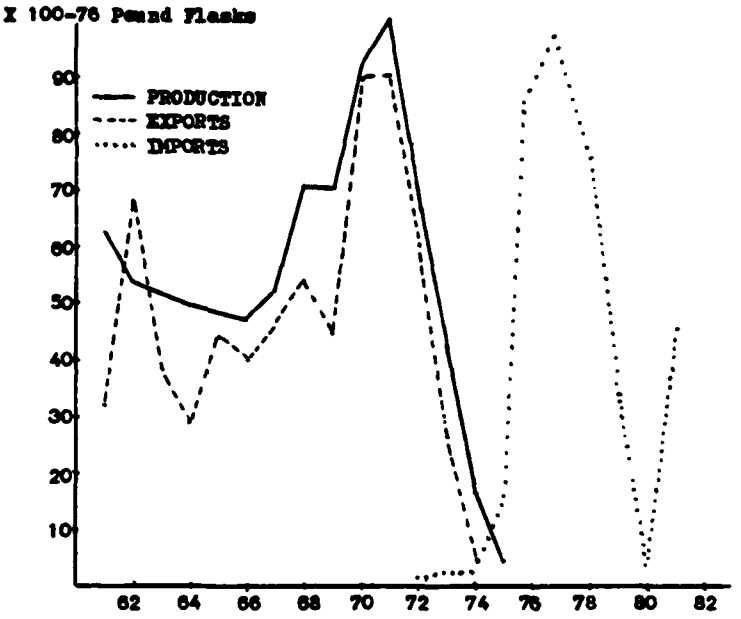


Figure 3-18: Annual Production, Imports, and Exports of Mercury in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

TIN

The Philippines is 100 percent import-dependent for tin supplies with a very erratic import pattern as shown in Figure 3-19. This is because of the lack of supply contracts and buying on the spot market when supplies run low.[5] Most imports are from Malaysia.

TITANIUM

The Philippines is also 100 percent import-dependent for titanium supplies. Figure 3-20 shows the pattern of

titanium imports, indicating a dramatic decline in the past 10 years. The primary sources of titanium oxides and hydroxides are Japan, Australia, the United States, and the United Kingdom. Nearly all of the titanium imported is used in the manufacturing of pigments.[5]

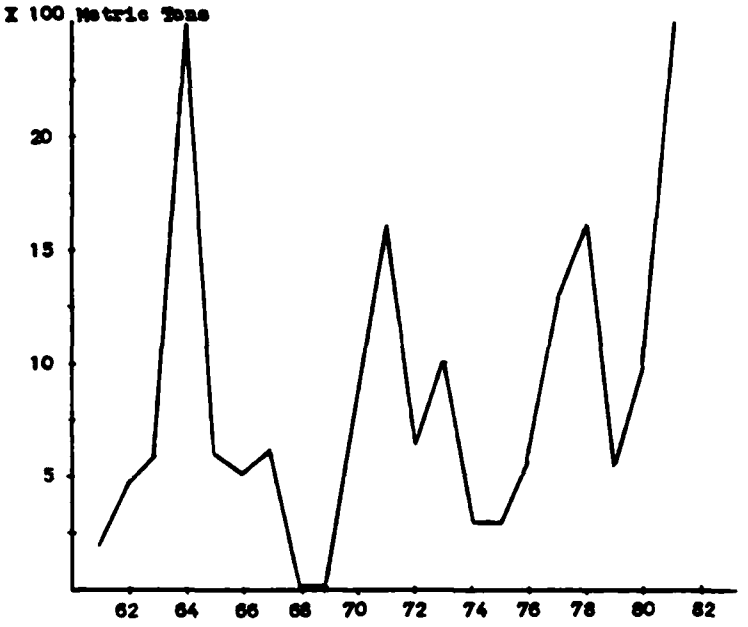


Figure 3-19: Annual Tin Imports in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

PLATINUM GROUP METALS

Platinum is found in the Philippines as small flakes in placer deposits, and is in sufficient concentrations to permit economical mining operations on Luzon and Mindanao Islands.[2] The Philippines has an unpredictable pattern of imports, exports, and production of platinum and palladium. The Acoje Mining Co. reported production in the late 1950's and early 1960's, and then ceased production until 1970, then began

producing again and stopped in 1975.[5] The average production of platinum was about 3000 troy ounces per year.

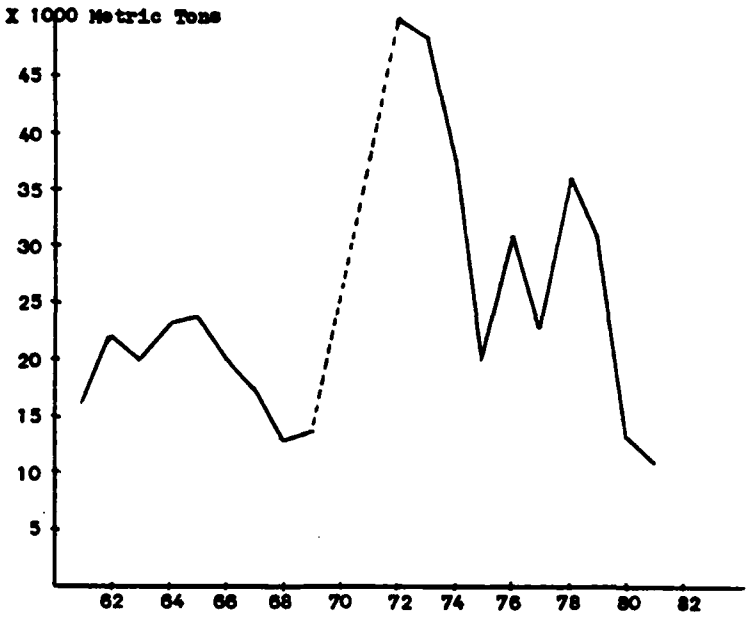


Figure 3-20: Annual Titanium Imports in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

NON-METALLIC MINERALS

CEMENT, SAND, AND GRAVEL

Cement, sand, and gravel are presented here to illustrate the magnitude of growth in construction in the Philippines in expanding factories, plants, building homes and roads, and making other infrastructure improvements. In order to minimize transportation costs, the government has been striving to insure that all cement is produced domestically, although some imports and exports have been necessary in the past.

Cement production has been steadily increasing since 1961 and has tapered off in the 1980's, only because of the

government's inability to continue massive borrowing from the World Bank to develop infrastructure.[3] The building industry in the Philippines has been booming at such a rate that cement has become the second most important commodity in the country. A ban on all cement exports was placed into effect in 1973, but the industry was able to react so quickly that it was lifted in June 1974.[32] There are over 19 cement-producing companies in the Philippines. The major companies are: Republc Cement Corp., Rizal Cement Co., Bac noton Cement Co. (a U. S. firm), Koppers Corp., Marinduque Mining and Industrial Corp., and Midland Cement Corp.

Figure 3-21 shows production, imports, and exports of cement in the Philippines. Production capacity in 1981 was 7.2 million tons from 18 cement plants. High energy costs, outmoded equipment, and inefficient plant size are cited as reasons for the low-capacity utilization this industry is experiencing. (Production is only 61 percent of capacity.)[18] According to the Philippines' cement industry sources, the fuel cost alone accounted for over 75 percent of production costs in 1981. The government immediately began action to convert the cement plants and mines from oil to coal. During 1981 and 1982, 17 plants began converting to coal, and four completed this conversion with the rest due to finish by 1985.[17]

Figure 3-22 shows the production of sand and gravel, clearly indicating that numerous construction projects have been undertaken in the Philippines since the mid-1960's. The sharp decline in the mid-1970's was caused by energy shortages.

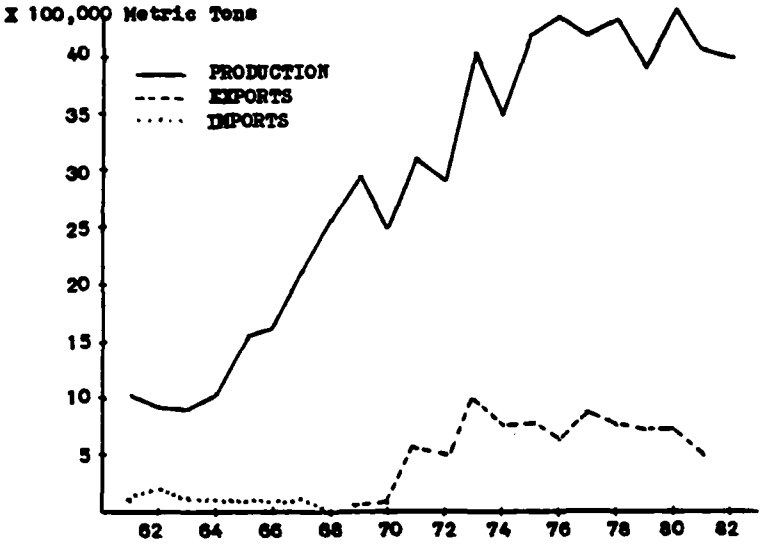


Figure 3-21: Annual Production, Imports, and Exports of Cement in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

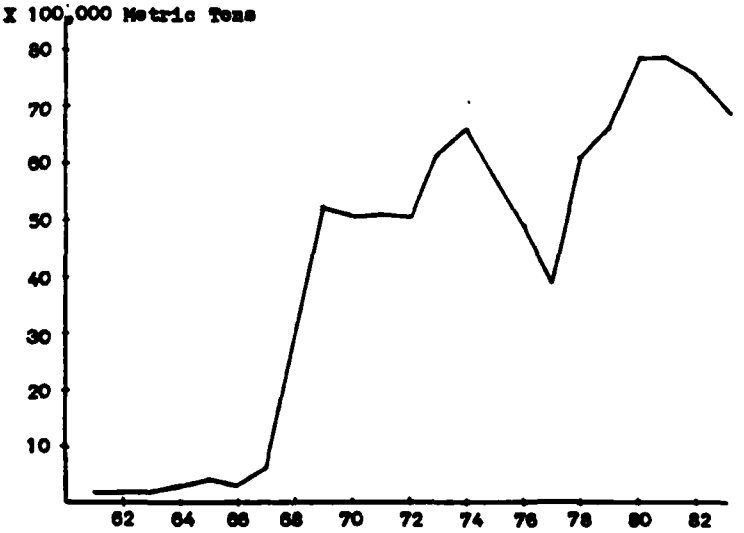


Figure 3-22: Annual Sand and Gravel Production in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

ASBESTOS

Asbestos occurs in the Philippines in extremely rugged areas in veins along with serpentine, amphiboles, and schists. Asbestos-bearing minerals include chrysotile, tremolite, and actinolite; and their geographical location has made them difficult to mine economically.[2]

The Philippines was approximately 75 percent import-dependent for asbestos supplies until 1969. With the booming building industry and increased modernization, more asbestos has been required for thermal and electrical insulation in cars, buildings, and appliances, and as a result, domestic production was expanded to such a degree that all known reserves were depleted in 1976.[5] Presently, the Philippines is 100 percent import-dependent for asbestos supplies. Figure 3-23 shows the steady increase in asbestos imports and the decline in production in the mid-1970's, ending in 1976.

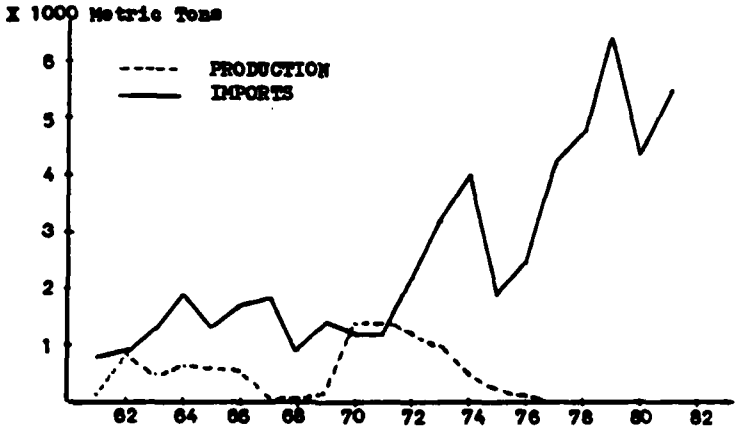


Figure 3-23: Annual Production and Imports of Asbestos in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

BARITE AND WITHERITE

The Philippines has dramatically improved its self-sufficiency position on barite and witherite in the past 20 years. Since 1960, this position has changed from 65 percent import-dependent to totally self-sufficient.[5] Figure 3-24 shows annual production, imports, and exports of barite and witherite in the Philippines.

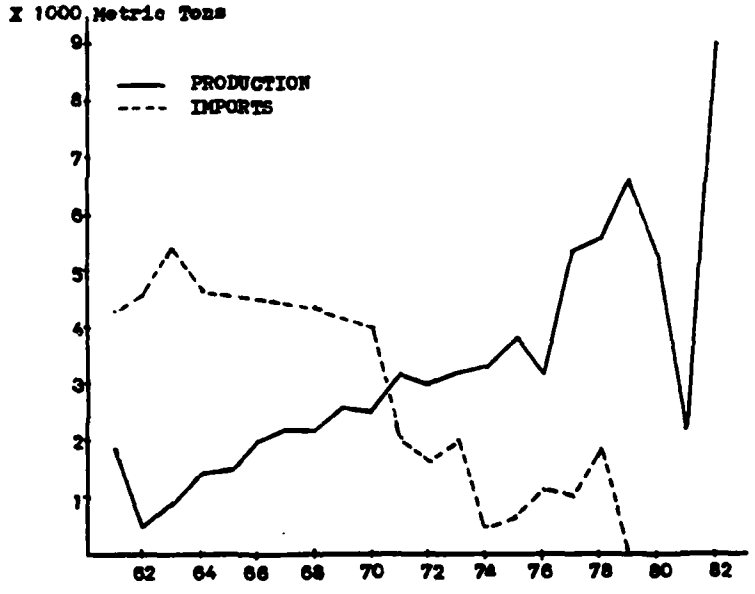


Figure 3-24: Annual Production and Imports of Barite and Witherite in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GYPSUM AND ANHYDRITE

In the Philippines, gypsum and anhydrite occur around volcanic fumaroles, which are natural vent pipes which emit gases.[2] Gypsum and anhydrite, like cement, sand, and gravel, became important in the Philippines due to the massive scale of construction from the early 1970's to the present.[5] The

Philippines became import-dependent for gypsum and anhydrite in the 1970's because known reserves were depleted rapidly.[5] The import-position changed considerably in 1976 when synthetic gypsum and anhydrite became a reality in the Philippines. If the productive capacity of synthetic wallboard is increased, imports will be reduced, but with the Philippine debt situation, capital is not available for expansion of synthetic gypsum at the present time.[3] Figure 3-25 shows the production and imports of gypsum in the Philippines.

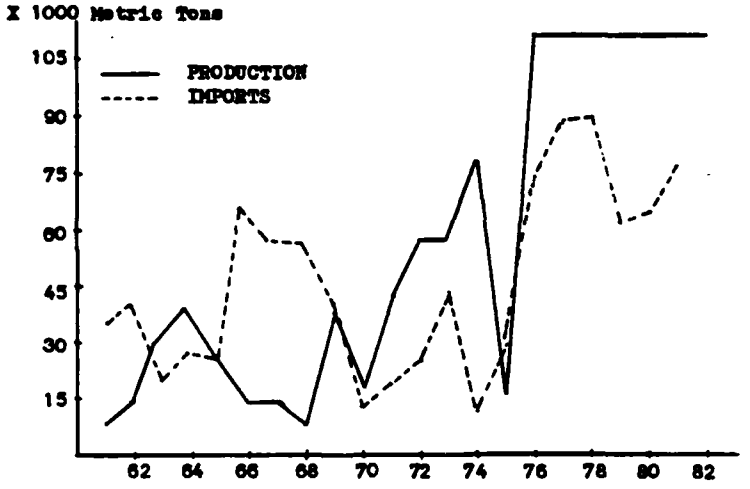


Figure 3-25: Annual Production and Imports of Gypsum in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

LIME AND LIMESTONE

The production and imports of lime and limestone has increased considerably in the past decade in the Philippines. Lime and limestone is used extensively as fertilizer, a flux in steelmaking, as a constituent of cement, and for dimension stone. Production of lime and limestone is on the island of

Luzon, primarily in the north. The magnitude of production and imports of lime and limestone is shown in Figure 3-26.[29]

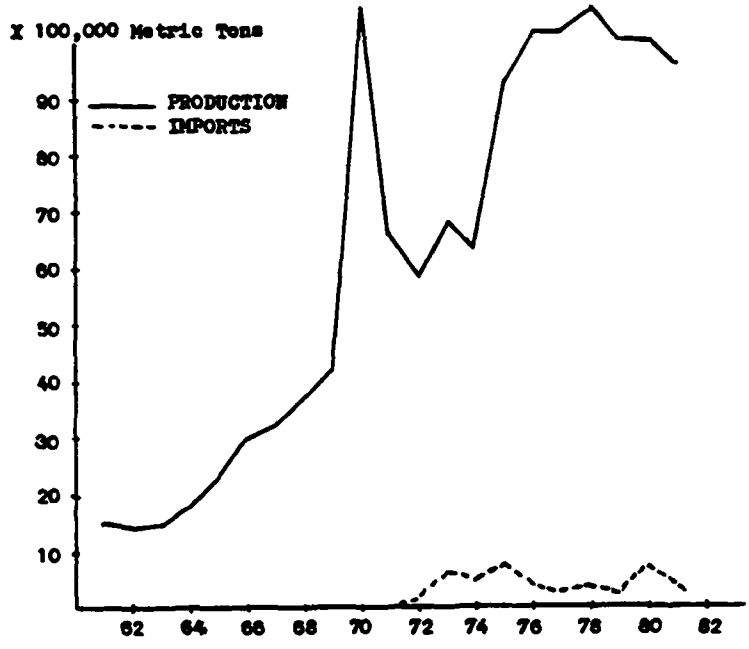


Figure 3-26: Annual Production and Imports of Lime and Limestone in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

FERTILIZER

Despite extensive government effort to expand production, fertilizer production peaked in 1975 at 300,000 tons.[5] Presently, the Philippines is 93 percent import-dependent for fertilizer, including potassium, phosphates, nitrogen, and mixed fertilizers. Imports have climbed significantly since 1961, as shown in Figure 3-27, while production has been stagnant.

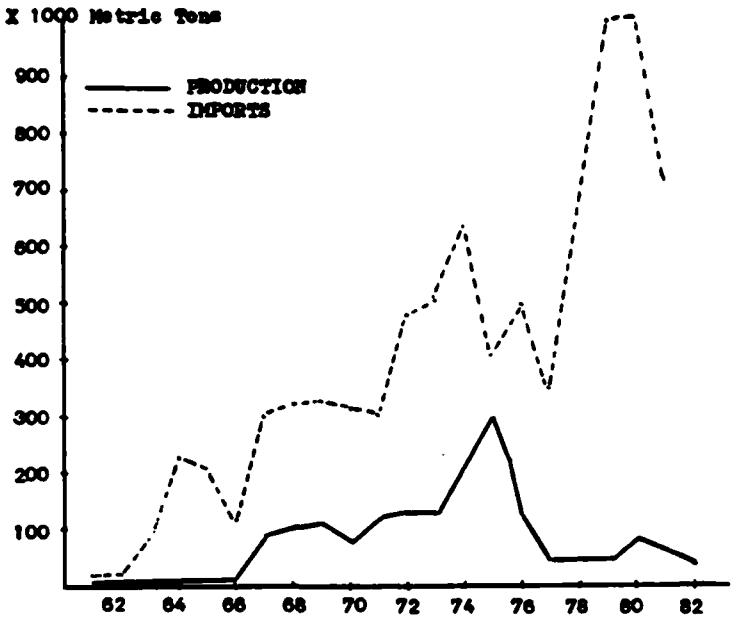


Figure 3-27: Annual Production and Imports of Fertilizer (All Types) in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

FELDSPAR AND FLUORSPAR

Fluorite is mined as a gangue mineral from many of the epithermal veins which produce other minerals. The Philippines could be self-sufficient for fluorite supplies if more metal mining companies would extract the fluorite as a byproduct of their mining operations.[5] The Philippines was totally self-sufficient until 1968, and presently must import 15 percent of requirements from India, Japan, Italy, and the United States.[17] Feldspar is used in the porcelain industry and fluorspar is necessary for steelmaking. Figure 3-28 shows production and imports of fluorite and feldspar in the Philippines.

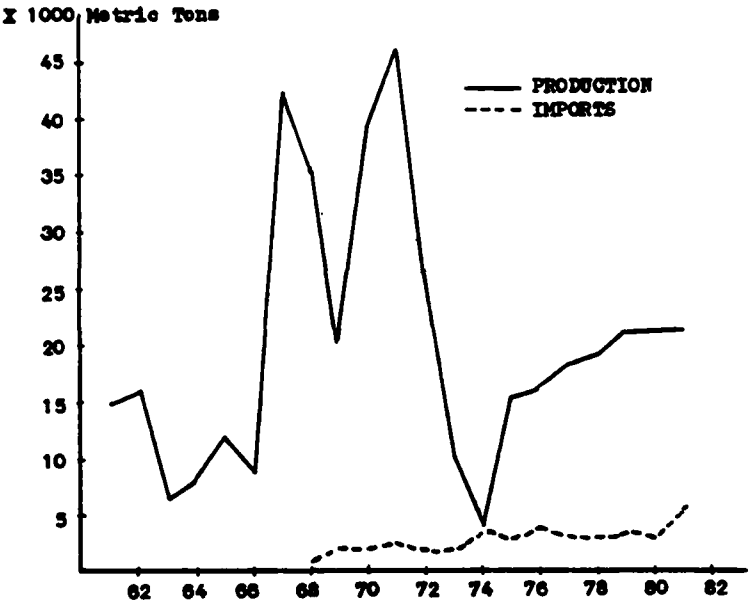


Figure 3-28: Annual Production and Imports of Feldspar and Fluorspar in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

TALC

The Philippines is approximately 27 percent self-sufficient on talc, a mineral used in cosmetics, ceramics, rubber, lubricants, and soap. The major import source is South Korea, providing over 82 percent of all imports.[17] Production of talc is concentrated on Luzon and Mindoro Islands, and is susceptible to bad weather interruptions.[5] Figure 3-29 shows talc production and imports in the Philippines.

SALT

With a growing population and industrial base, the Philippines' consumption of salt is outpacing production. Benguet Consolidated, Inc. is the only major salt producer in the Philippines and produces salt from three sources.

One is a huge salt deposit on the island of Negros, containing over 10 million tons of salt. Production capacity at this deposit is 2600 tons per day. A second source of salt is from salty hot springs on northern Luzon Island, but this is also a minor source of supply.[2] The majority of salt production is from the sea in 15 provinces, using solar evaporation ponds. The main problem with evaporating sea water to obtain salt is that it is highly dependent upon dry weather. Destructive rains and typhoons in 1971 nearly destroyed all salt-making capacity from the evaporation ponds, forcing the Philippines to import over 110,000 tons of salt in 1972 from India, Australia, and Pakistan.[33] Figure 3-30 shows salt production and imports in the Philippines. It took over 6 years to fully recover from the 1971 typhoons.

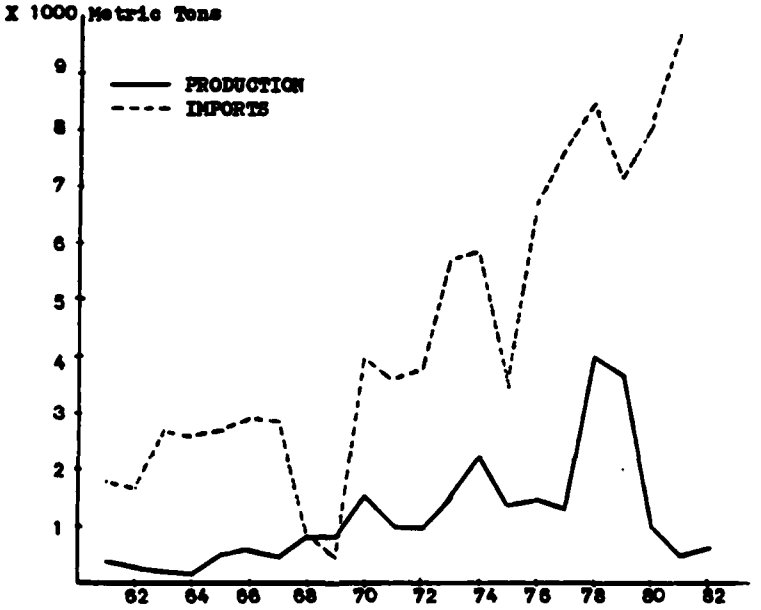


Figure 3-29 : Annual Production and Imports of Talc in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

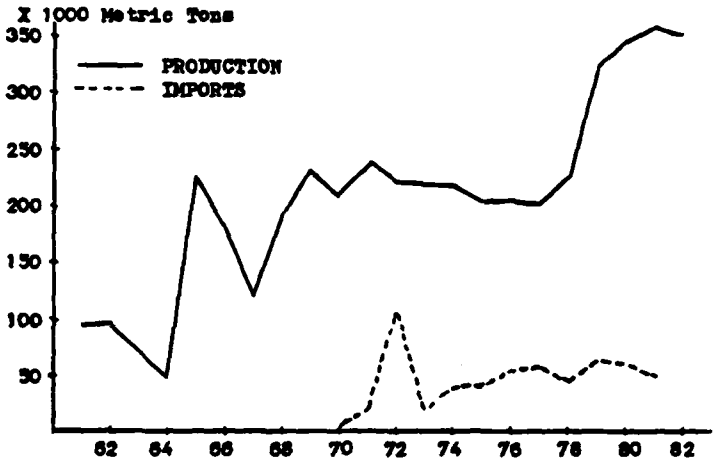


Figure 3-30: Annual Production and Imports of Salt in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

SULFUR

The Philippines has been largely self-sufficient in sulfur supplies with Benguet Consolidated, Inc. developing large deposits, but production reached a peak in 1974. A contributing factor to this is the fact that sulfur is a byproduct of gypsum, and in 1978, natural gypsum production was suspended. Demands in recent years have been skyrocketing due to industrial expansion, causing large imports.[5] In 1981, imports reached 139,000 tons, mostly from Japan, accounting for over 81 percent of total imports.[18] Figure 3-31 shows production and imports of sulfur in the Philippines.

PYRITE AND PYRRHOTITE

Pyrite and pyrrhotite are discussed because of their relationship with the production of sulfuric acid and sulfuric oxide. Pyrite is burned to produce these substances. Figure 3-32 shows pyrite and pyrrhotite production declining, but it

is not due to nonavailability. The demand for domestic sulfuric acid is not as great as it used to be in the Philippines.[5] Now much of it is imported at a lower cost than it can be produced domestically, mainly because of high energy costs.

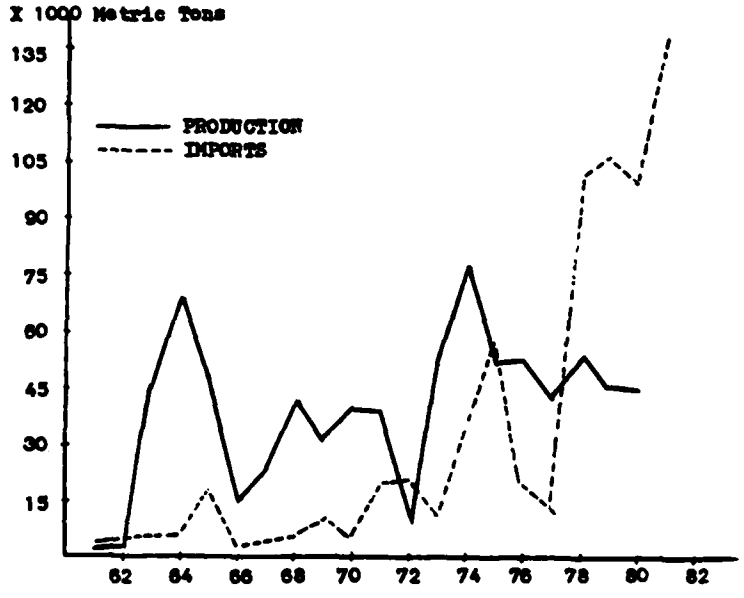


Figure 3-31 : Annual Production and Imports of Sulfur in the Republic of the Philippines, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

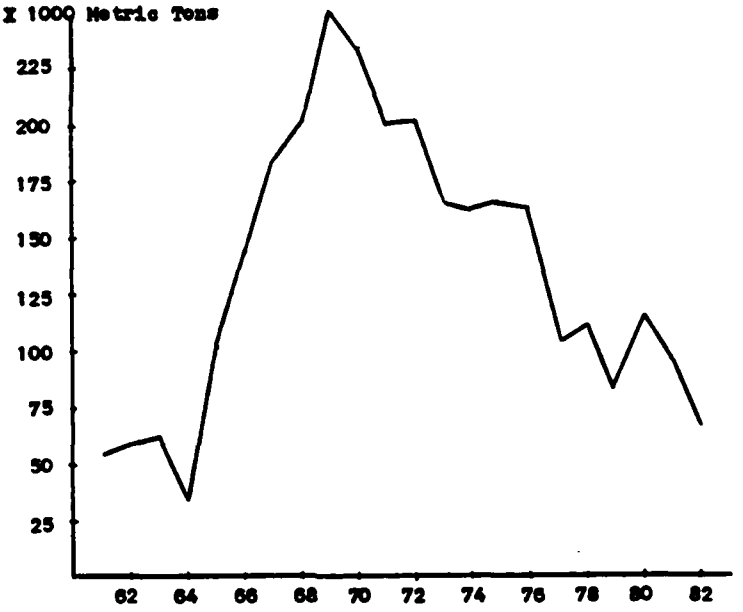


Figure 3-32: Annual Production of Pyrite and Pyrrhotite in the Republic of the Philippines, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

GOVERNMENT POLICY STRATEGIES

The Philippine Government has consistently been very active in promoting industrial growth. In 1963-1967, a five-year program was implemented, boosting private industry by promoting joint ventures. Preferential treatment, including numerous tax concessions, were offered to foreign investors.[34] When President Marcos was first elected to the presidency, he promised government reform, including public works, highways, dams, and irrigation. In 1972, he revised tariff and customs codes by reducing the number of tariff items from 43 to 6. He initiated a uniform ad valorem tax of 10 percent and he changed the basis for evaluating imports. A high priority was placed in force to develop and exploit mineral deposits.[35]

In 1974, a twelve-year program was initiated to reduce

dependence on oil imports by exploration and development of coal, geothermal energy, hydroelectric power, nuclear power, and certainly domestic oil supplies. The government wanted to reduce the time from discovery to exploitation of minerals, and adopted the policy that all mines must be productive within 5 years after discovery.[5] The government is in the process of implementing 11 projects to further promote foreign exchange and energy independence. They are intended to diversify industry and process ores domestically instead of exporting raw materials. These projects include the construction of a copper smelter and an aluminum smelter, building a diesel engine manufacturing plant, development of heavy engineering industries (metal-working), rehabilitating and expanding the cement industry, coconut industry rationalization (downstreaming), manufacturing of alcogas (gasohol), construction of a pulp and paper mill, and designing and building a petrochemical complex.[36]

The Philippine Government's mineral policy is to encourage joint ventures between Philippine companies and foreign firms. Foreign investment is generally limited to 40 percent of a project, but in certain pioneer and export-oriented industries, it can be up to 100 percent. Industrial investment is very attractive to foreign firms, especially the electronics, electrical equipment, processed food industry, and export manufacturing industries.[37]

The following incentives are presently part of the Philippine Government's foreign policy on investment from foreign firms or governments: (a) foreign ownership of 30 percent

or less in new ventures do not need government approval, only registration; (b) foreign ownership of over 30 percent must be determined to benefit the overall Filipino economy; if it does, it is easily approved; (c) once approved, money can be repatriated freely, subject only to Central Bank emergencies in effect at the time; (d) the government will protect patents, copyrights, and trademarks of properly registered companies; (e) for pioneer, export-oriented companies, exemption from many import duties is allowed, and other tax exemptions are permitted with approval of the Board of Investment; (f) there are no known investment disputes or expropriation or nationalization cases outstanding, and the President stands firm on the policy of no expropriations or nationalizations; (g) Philippine policy is firm and stable; no changes are anticipated except possibly lessening restrictions on the extractive industries; and (h) labor is readily available, cheap, and well-educated.[37]

RELATIONS WITH THE UNITED STATES

The United States and the Philippines are currently enjoying very good relations, politically, but these relations were not so good during the Carter Administration due to the widespread human rights violations taking place under President Marcos. President Reagan's Administration tends to overlook these abuses.[3]

Currently, United States corporate investments in the Philippines total $4.5 billion. Table 3-14 shows the

corporations from the United States and their investments in the Philippines.[3] With the Philippines' national debt situation as it is, U. S. corporations could be tempted to invest more money in the Philippines because the government will have to give them a majority share in new ventures.

Table 3-14. U. S. Corporate Investments in the Philippines (1980)

Corporation	Philippine Assets (x $1000)
Mobil Oil Co.	$482,600
Proctor and Gamble	229,800
Pepsico	416,900
Ford	327,000
Colgate-Palmolive	217,150
Carnation	161,000
Union Carbide	157,100
Goodyear	175,000
BF Goodrich	253,600
Firestone	151,400
IBM Phils, Inc.	172,400
Johnson and Johnson	103,700
Coca-Cola	114,100
Armco	201,400
Kodak	81,800
Pfizer	48,600
Borden	79,100
Exxon	55,400
NCR	44,900
Kraft	36,500
Bristol	31,600
Dow Chemical	11,500

Source: Forbes, August 18, 1980.

The United States was the source of over 20 percent of all Philippine imports in 1982, and the destination of over 30 percent of exports. Trade in 1982 was $3.3 billion. The United States also holds notes on over one-third of the Philippines' external national debt.[38]

TAXES IN THE PHILIPPINES

The Philippines claim territorial jurisdiction for taxation on all non-residents for individual and corporate income. In 1966, an international tax relationships treaty was signed between the United States and the Republic of the Philippines. This treaty covered regulations and rulings affecting the international allocation of income and statutory income tax treatment of United States residents and businesses operating in the Philippines. The major development resulting from this treaty was to give the United States corporations relief from double taxation by both the United States and the Philippines.[39] Presently, both countries grant a tax credit for taxes paid to the other, as stipulated in the 1966 income tax treaty.

The Philippines currently levies a 30 percent internal corporate income tax and a 30 percent withholding tax on dividends going abroad. The remaining dividends are taxed as personal income.[40] The tax percentage is reduced by the Philippine domestic incentives provisions and by tax credits for taxes paid to other countries.

POLICY ANALYSIS CONSIDERATIONS

The Republic of the Philippines has been an important source of raw materials to the United States and its Far East allies, especially chromite, nickel, copper, cobalt, and gold. During World War II, when Japan was at war with the United States, this source of minerals was lost, and the United States

used military force to get it back. The United States has two large strategic military bases in the Philippines. These bases have been the target of numerous political rallies against the present Philippine Government. The United States must maintain friendly relations with the Philippines to keep its strategic military bases open in the country, and to ensure supply continuity of chromium, copper, cobalt, gold, and nickel to its Pacific allies.

From a strategic defense standpoint, it is in the best interests of the United States to assist the Philippines in economic and national defense measures. Should the Republic of the Philippines fall under Communist control, a centralized Communist base of operations in the Western Pacific area could be established, and this would greatly enhance the Soviet Union's ability to spread and dominate the rest of the small nations in that part of the world.

If the Marcos Government topples, or if it loses the elections to the Opposition Party in the Philippines, all policies concerning relations with the United States, expropriations, nationalization, repatriation, and corporate investment rules could be changed. This must be carefully considered by both the United States' policymakers and by U. S. corporations. Both stand to lose considerably if wrong political or investment decisions are made concerning the Republic of the Philippines.

REFERENCES

1 Nena Vreeland, et al., Area Handbook for the Philippines, 3d Ed. (Washington, D. C.: U. S. Government Printing Office, 1982).

2 Philippine Bureau of Science, Manila, Geology and Mineral Resources of the Philippine Islands (Manila: Bureau of Printing, 1924).

3 Donald Swansan, "A Close Look at the Philippines," Forbes, August 18, 1980.

4 Republic of the Philippines Department of Agriculture and Natural Resources, Bureau of Mines, Manila, Information Circular No. 16 (Manila: Bureau of Printing, June 1953).

5 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1960-1981).

6 Anon., "Philippine Credit Availability Should Hold Lid on Imports in 1983," Business America, February 21, 1983.

7 Anon., "Philippine National Power - Westinghouse and Manila Settle Nuclear Dispute," Wall Street Journal, September 26, 1980, Sec. 2, p. 34e.

8 Anon., "Filipinos' Cocodiesel is Fueling Vehicles and Buoying Price of Coconut Oil Crop," Wall Street Journal, May 29, 1981, Sec. 2, p. 40e.

9 Anon., "Geothermal to Gain in Philippine Energy Mix," Oil and Gas Journal, March 2, 1981.

10 Dominado Z. Rosell, "Suggested Research and Development of the Water Resources in the Philippines," The Philippine Geographical Journal, October 1982.

11 Perfecto V. Guerrero and Domingo C. Salita, "National Resources - Impact of Exploitation on Environment in the Philippines," The Philippines Geographical Journal, October 1980.

12 Anon., "What's Going on in World Mining," World Mining, 1973-1984.

13 Anon., "What's Going on in World Mining," World Mining, April 1977.

14 Anon., "What's Going on in World Mining," World Mining, August 1977.

15 National Geographic Society, Atlas of the World, 5th Ed. (Washington, D. C.: National Geographic Society, 1981).

16 Anon., "Worldwide Survey," World Mining, June 25, 1975.

17 John C. Wu, "The Mineral Industry of the Philippines," Minerals Yearbook, 1982 Reprint (Washington, D. C.: U. S. Government Printing Office, 1983).

18 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook, 1981 Reprint (Washington, D. C.: U. S. Government Printing Office, 1982).

19 U. S. Department of the Interior, Bureau of Mines, Mineral Commodity Data Summaries (Washington, D. C.: U. S. Government Printing Office, 1977-1982).

20 Anon., "Philippines Subsidizes its Copper Production to Keep Mines Running," Wall Street Journal, July 6, 1982, Sec. 2, p. 29e.

21 Philippines Bureau of Commerce and Industry, Concentration in Philippine Manufacturing, 1970-1980 (Manila: Bureau of Government Printing, 1983).

22 Anon., "High Price of Gold Bullion Spurs Gold Mining Revival," World Mining, May 1978.

23 Anon., "Worldwide Survey," World Mining, June 25, 1974.

24 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1977).

25 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1965).

26 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (washington, D. C.: U. S. Government Printing Office, 1968).

27 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1970).

28 Anon., "Worldwide Survey," World Mining, June 25, 1976.

29 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1978-1979).

30 Anon., "Worldwide Survey," World Mining, July 25, 1979.

31 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1976).

32 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1974).

33 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1973).

34 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1963).

35 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Philippines," by John C. Wu, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1972).

36 Anon., "Energy Diversification Program, 11 Major Projects Provide Outlets for Sales While Economy Marks Time," Business America, November 2, 1981.

37 Anon., "Philippines Lures Investors with Attractive Package of Incentives," Business America, September 20, 1982.

38 Michael H. Armocost, "U. S. - Philippine Economic Relations," Forbes, August 1, 1983.

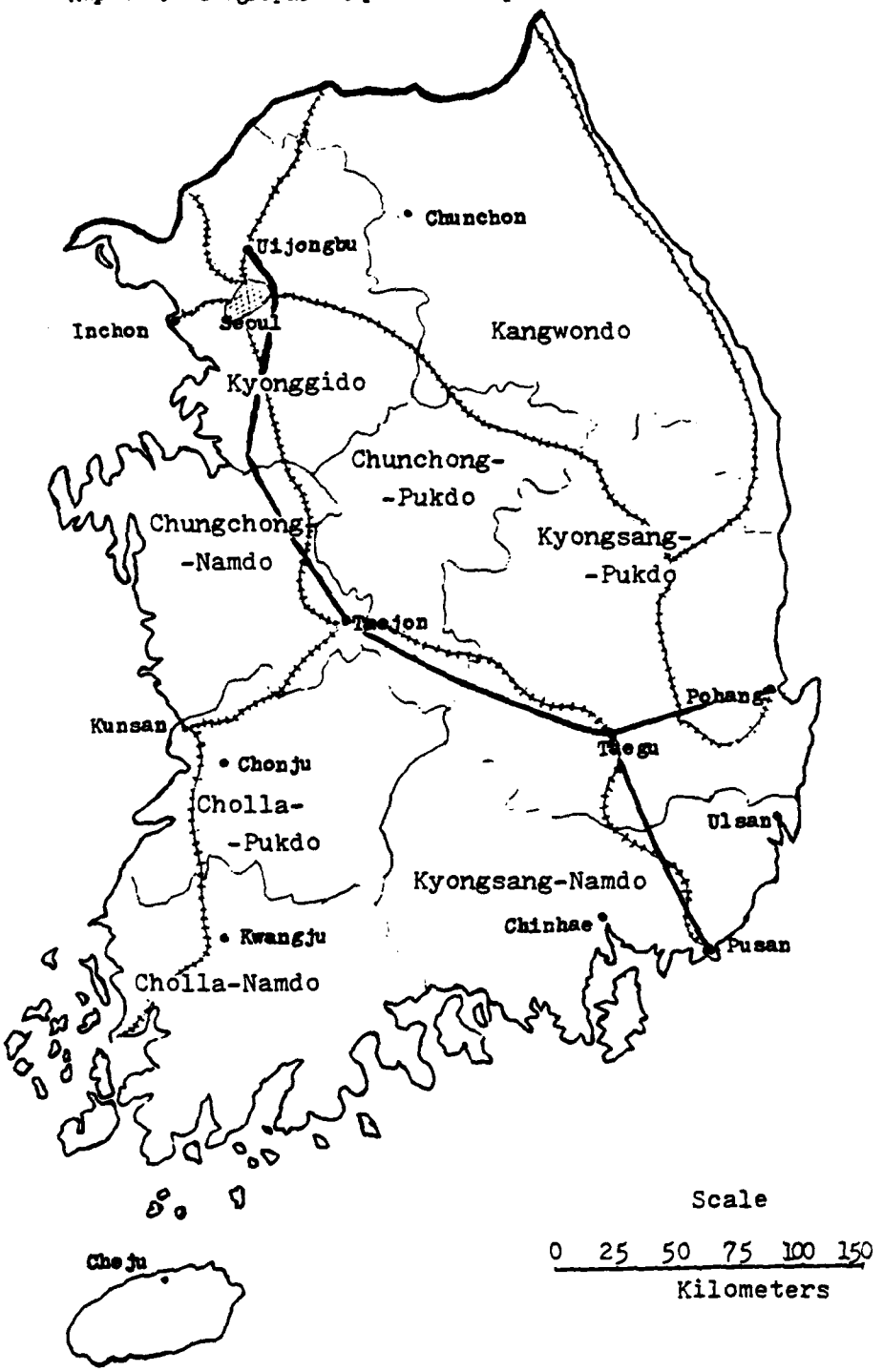
39 R. Palmer Baker, Jr. et al., Taxation of Foreign Income by United States and Other Countries (Princeton: Tax Institute of America, 1966).

40 John F. Chown, Taxation and Multinational Enterprise (London: Lognman Group Limited, 1974).

CHAPTER FOUR:

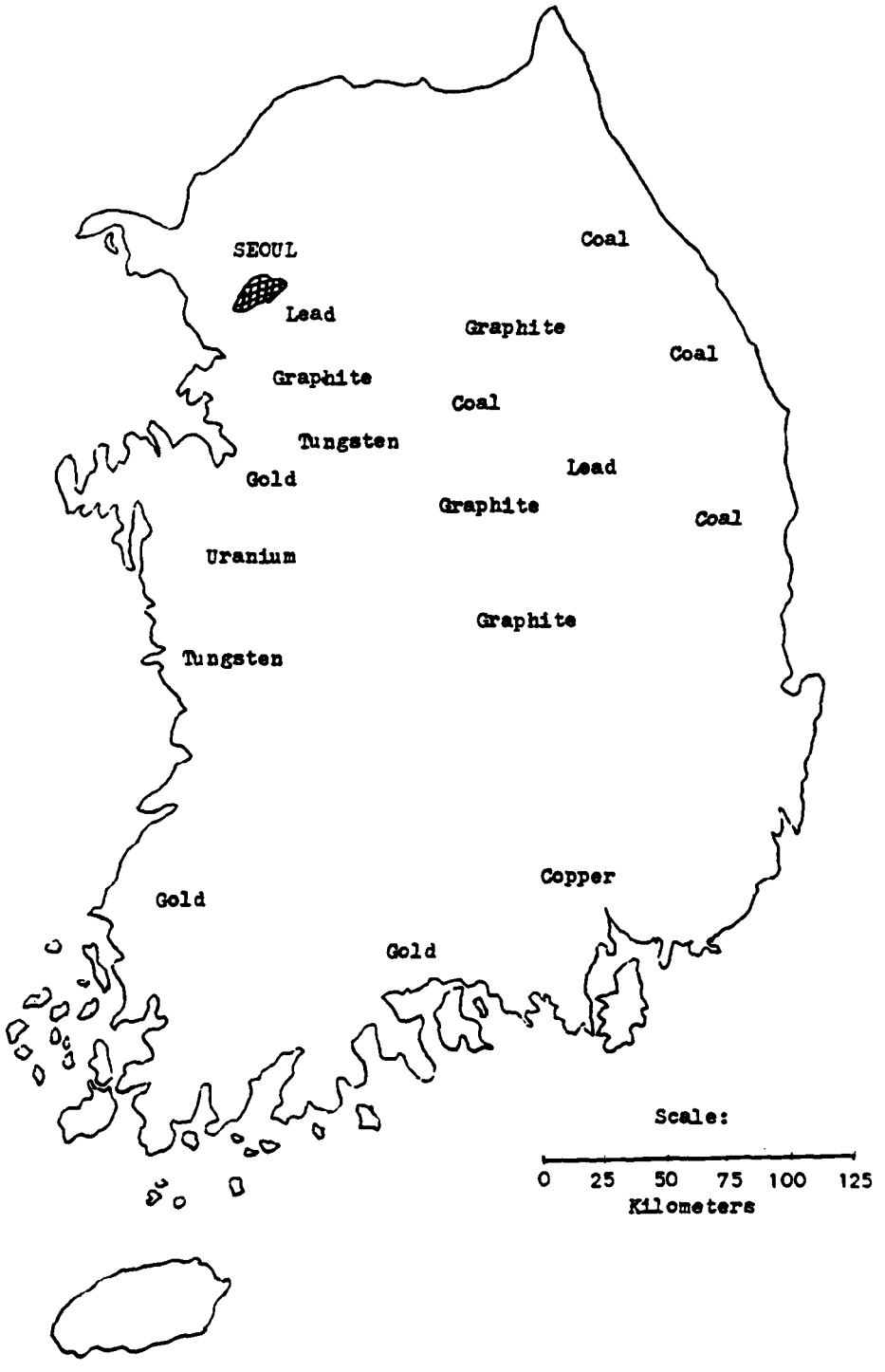
THE MINERAL INDUSTRY OF THE REPUBLIC OF KOREA (SOUTH KOREA)

Map 4-1. Geographic Map of the Republic of Korea



Source: The International Atlas, Rand McNally and Company, 1981.

Map 4-2. Mineral Distribution in the Republic of Korea



Source: The International Atlas, Rand McNally and Company, 1981.
Area Handbook of South Korea, Washington, D. C., 1982.

INTRODUCTION

The Republic of Korea (South Korea) is a peninsular nation in the Western Pacific consisting of 98,477 square kilometers of total land area, 70 percent of which is mountains and uplands. The current population is 39.7 million people with an average growth rate of 1.53 percent per year. Seoul, the capital, has nearly 9 million inhabitants, and Pusan, a southern industrialized port city, has over 3.3 million.[1] Korea has an exceptionally high literacy rate of 93 percent, with elementary school being compulsory, and over 91.6 percent of all people educated to 9th grade level. Public education is the dominant means of educating students in Korea.[1]

Korea has a private enterprise economy with strong government control and influence through national planning and distribution of credit. The work force is large and well-educated. Additionally, the managerial force in Korea is one of the best educated in the world, with over 8000 young South Koreans continually working on graduate degrees in the United States at any one time.[2] There is a relatively equitable income distribution in Korea, compared to other private enterprise economy countries, but a growing inequity of wealth.[3]

The mining and extractive industry's share in the Korean economy has gradually fallen from 8 percent in 1963 to only 0.6 percent in 1982, experiencing negative growth. From an employment aspect, mining represents only 0.5 percent of the total labor force.[3] Table 4-1 shows the latest published labor distribution in South Korea.

Table 4-1. Distribution of Labor, 1981

Sector	Percentage of Labor Force
Agriculture, Forestry, and Fishing	34.0
Mining and Quarrying	.5
Light Manufacturing	9.7
Construction	3.7
Electric, Gas, and Water	.4
Commerce	15.1
Transport, Storage, and Communications	8.4
Services	19.1
Heavy Industry	5.0
Chemical Industry	4.1

Source: Area Handbook of South Korea, Washington, D. C., 1982.

The development of the industrial base in the Republic of Korea can be largely attributed to the strongly supportive government under the leadership of President Park Chung Hee, who served as president from 1961 to 1979.[1] Korea's rapidly expanding industrial growth has been accomplished despite a very limited mineral reserve base and almost no fossil fuel reserves. The main growth sectors have traditionally been the heavy and chemical industries, including a world competitive shipbuilding industry, but light manufacturing such as textiles is still important in the Korean economy.[1]

Growth in industry has been the principal stimulus to the economic development in Korea. Except for mining, most of the country's industry is located in the northwest and southeast, with the heavy industries in the south. In 1982, Seoul and Kyonggido Province produced 46 percent of the total industrial output and employed 48 percent of the nation's 2.4

million factory workers. Pusan and Kyongsand-Namdo Province produced 26.3 percent of total output and Taegu and Kyonsang-Pukdo Province produced 12.6 percent of all manufactures. Together, these two provinces in the southeast employ nearly 40 percent of all factory workers. All three of these major cities are located near or at major ports.[1] The government is trying to disperse the nation's industry. The first move was to place the shipbuilding industry at Ulsan (Between Pusan and Pohang). Additionally, the largest industrial park in the nation, the Changwon Integrated Machine Industrial Complex, with over 100 industrial enterprises, was located at Kwangju.[1]

GEOLOGY

As a mountainous peninsula, Korea is of diverse geology. Its mountainous terrain is composed of Pre-Cambrian rocks. To the northeast, just west of the drainage divide, geosynclinal deposits are found, ranging up to Triassic in age. To the southwest, Cretaceous and Tertiary sedimentary rocks are interspersed with granite intrusions. There are no active volcanos, and earthquake shocks are extremely rare, but the islands of Ullungdo and Chejudo are entirely volcanic in origin.[4] The Great Limestone Series, distributed mainly in the Kangwondo Province is a very thick sequence of limestone-rich sediments, overlain by quartzite. This sequence extends southward, nearly all the way to the southern coast, thinning southward.[4]

The majority of the ore deposits in South Korea are in

hydrothermal veins and are imbedded in granite, gneiss, and schists. Fine-grained replacement deposits in limestone occur in the east-central portion of the country. In the southern portion of the peninsula, a mixture of hydrothermal veins and skarns formed the ore bodies.[5] Other mineral deposits are located in dolomite country rocks, imbedded in limestone, marble, and gneiss, and in alterations in these country rocks from ultrabasic dikes.[6] On the extreme south-southeastern end of the peninsula, a small porphyry belt produces a few selective minerals, but only in modest quantities.[7] Still other types of ore deposits in South Korea include sedimentary, residual, and metamorphic deposits.[8] The geology of specific minerals is discussed later in this chapter in the commodity analysis section.

RESOURCE/RESERVE BASE

Much of South Korea has not been completely explored due to a lack of developed infrastructure in remote areas and because of the rugged terrain throughout most of the country. Although the Korean peninsula, as a whole, is rich in minerals, particularly iron and coal, most of the mineral resources and production capacity lie in North Korea. Only tungsten, a major export commodity, and amorphous graphite, mostly of poor quality, are located in South Korea. Production of minerals is concentrated in a roughly triangular belt, extending from the central east coast inland, with scattered production elsewhere. With a few exceptions, mineral production, particularly

of high grade ores, is not sufficient to meet domestic needs.[9]

Korea keeps most reserve figures confidential, but coal reserves were published in 1978 along with iron ore statistics. Coal reserves amounted to 1.5 billion tons, and although there is believed to be 112 million tons of iron ore resources, only 18 million tons are economically mineable, containing more than 40 percent ore grade.[3] Table 4-2 lists some of the published reserve figures in the Republic of Korea.

Table 4-2. Mineral Reserves in South Korea (Metric Tons)

Commodity	Reserves	Grade	Year of Estimation
Tungsten	2,400,000	.5% WO_3	1981
Molybdenum	80,000,000	.4% MoS_2	1981
Uranium	10,900,000	na	1981
Iron Ore	120,000,000	na	1974
Graphite (Amorphous)	35,000,000	na	1974
Graphite (Crystalline)	3,000	na	1974
Fluorite	660,000	40% CaF_2	1971
Manganese	750,000	na	1971

Source: World Mining, 1972-1984.

GROSS NATIONAL PRODUCT

Due to a successful export-oriented growth policy, Korea was able to achieve one of the highest economic growth rates in the world during the period from 1962 to 1976. Per capita income rose an average of 8 percent per year to $1500. GNP growth was 9.5 percent per year from 1961 to 1979, but in 1980, it was negative 5.7 percent, the worst since the Korean War in the 1950's. The economic slowdown was due to political instability (the assasination of President Park), inflation,

a huge oil import bill, and structural imbalances.[11] Since 1981, the government, under the new president (Major General) Chun Doo Hwan, has recovered from internal turmoil and has established an economic program with an optimistic growth future of 6-8 percent per year through 1986.[3] Table 4-3 shows the gross national product and the value of the mining industry for the past two decades in Korea. The 1983 GNP has been estimated to be over $75 billion.[2]

Table 4-3. Korea's Gross National Product (Millions of Dollars)

Year	GNP	Minerals and Mining	Percentage of GNP
1963	$2,900	$150	5.2
1964	3,300	198	6.0
1965	3,800	228	6.0
1966	3,356	201	6.0
1967	3,664	262	7.2
1968	4,168	263	6.3
1969	4,822	270	5.6
1970	8,200	270	3.3
1971	9,104	345	3.8
1972	9,800	360	3.7
1973	11,466	414	3.6
1974	17,200	176	1.0
1975	18,700	197	1.1
1976	25,000	250	1.0
1977	35,500	250	0.7
1978	47,700	474	1.0
1979	61,100	611	1.0
1980	57,600	715	1.2
1981	60,566	398	0.7
1982	64,300	386	0.6

Source: Minerals Yearbook, U. S. Bureau of Mines, 1961-1982.

NATIONAL DEBT

The Republic of Korea has paid the price for its extremely rapid industrial growth over the past 20 years. South Korea is termed "Asia's most heavily debted nation," with a

current external national debt of $40.6 billion, and it is estimated that this debt will be $47.6 billion by 1986.[12] With respect to the GNP, South Korea's debt has grown so large that there are fears that the World Bank will impose a credit limit on the nation as it did in the Philippines, but thus far, Korea has had no problem in obtaining capital. In 1983, South Korea raised $500 million from the London Interbank and from U. S. banks to be loaned to private industry. South Korea is also seeking an additional $700 million from the World Bank.[13]

There is presently no indication that South Korea will have to reschedule any debt payments, therefore, as far as the World Bank is concerned, South Korea will be able to continue to borrow.[14] Korea displayed a remarkable ability to recover from a political crisis, and the government is taking aggressive steps to reduce the national debt by increasing exports 15 percent by 1986 to $53 billion from $20.8 billion in 1981. This plan includes expansion of 11 industries by 1986, and 19 separate projects to increase exports. The major industries affected are ceramics, tires, footwear, and lead smelting.[15] At the same time, to curb inflation and the national debt, major projects such as the Inchon harbor expansion, construction of nuclear power plants, dams, railroads, and others are being delayed.[12] Other actions being taken are reduced national budget and plans to increase revenue from industrial monopolies owned by the government and higher taxes.[16]

ENERGY MIX

The Republic of Korea's Government is very actively striving to change the nation's energy mix which is presently almost completely dominated by imported oil. Programs to improve the energy situation in Korea are underway, but energy self-sufficiency does not appear to be a viable goal.[10] In an effort to increase domestic production of energy, the Korean Electric Co. Ltd. (government-owned) has commissioned the nation's first nuclear power plant in 1981 with two additional plants to be operational by 1984.[1] Additionally, a high grade uranium deposit was discovered in 1980 near Okchon, 85 miles south of Seoul. The Korean Resources Development Institute said it contains over 10.7 million tons of uranium ore.[17] A nuclear fuel processing plant capable of processing 200 tons of uranium reactor rods per year will be completed by 1988 in a joint venture with France. These rods will be exported until 1990 when Korea plans to operate 10 new nuclear power plants, each having a capacity of 900,000 to 950,000 kilowatts.[18] Korea is fortunate in that public opposition to nuclear power is almost nonexistent.[1]

In Korea, industry uses over 73 percent of the total energy with the major users in the textiles, metals, chemicals, and machine building industries. Nuclear energy is 80 percent cheaper than oil-generated power with average electricity prices 30 percent higher in Korea than in other western Pacific countries. By 1986, the Ministry of Energy and Resources wants dependence on oil down to 35 percent, mainly by increasing

nuclear and coal electric power generation capacity.[1] Table 4-4 shows the trends in the national energy mix in South Korea and the planned energy mix for the year 1991.[10]

Table 4-4. South Korea's Energy Mix, Percent of Total

Energy Source	1961	1978	1981	1991
Charcoal	57.1	8.4	0	0
Coal	33.3	27.1	10.0	64.0
Petroleum	8.0	61.0	75.0	3.0
Nuclear	0	1.6	9.0	30.0
Hydroelectric	1.6	1.9	6.0	1.0
Solar	0	0	0	2.0

Source: An Assessment of the Role of Coal in the Long-term Energy Plan for Korea, Monterey, March 1982.

South Korea: A Country Study, Washington, D. C., 1982.

WATER AVAILABILITY

South Korea has a plentiful water supply in most of the country. With 70 percent of the nation being occupied by uplands and mountains, the country has an efficient drainage system with numerous springs that flow all year. This is important for keeping large acreages of rice paddies flooded 4 months each year. Because of the poor sanitation systems, and the use of human waste as fertilizer, the river waters are often polluted with bacteria, and drinking water generally has to be boiled before it is safe to drink.[1]

ENVIRONMENTAL CONSIDERATIONS

Except for densely populated areas, little concern for the physical environment exists in South Korea. The only action being taken that could lessen pollution in the industrial-

ized areas is the government's efforts to relocate industries to reduce the nation's vulnerability to catastrophic damage in case of an air or missile attack, and to relieve the conjestion in the major industrial centers of Seoul and Pusan. The government in Korea does not allow organized activist groups in any area of the country.[1]

INFRASTRUCTURE

Korea has a fairly integrated transportation system that has been largely developed for national defense purposes. The shoreline around Korea has numerous naturally occuring harbors, and the government has developed many of them into commercial ports. There are currently 2 ports capable of handling the largest ocean carriers, and 10 other major ports, and 16 minor ports in the country. Table 4-5 lists the major ports in Korea.[19]

Table 4-5. Major Ports in South Korea

Pusan*	**Pohang**	**Ulsan**	**Inchon***
Mukho	**Kunsan**	**Chinhae**	**Nasan**
Yosu	**Cheju**	**Samchonpo**	**Sokcho**
Mokpo			

***Largest Ports**

Source: South Korea: A Country Study, Washington, D. C., 1982.

Road networks are the worst segment of South Korea's transportation system, with only 46,951 kilometers of roads; 60 percent are gravel-covered, 30 percent are paved, and 6 percent are unimproved.[19] All major cities are linked together

with 1268 kilometers of well-developed expressways. Over half of all cargo transported inland in Korea is shipped by trucks. Passenger travel by bus is cheap, efficient, and heavily used. The bus transportation system is so large in Korea that Myung Jin Transportation Co. Ltd. and Han Jin Transportation Co. Ltd. are among the largest conglomerate enterprises in the country. An interesting point to note is that, because of the severe problems with traffic conjestion during the Korean War, very little petroleum is transported over roads in Korea. The United States Army operates a major underground multi-product pipeline system, called the Petroleum Distribution System Korea (PDSK), which connects the port cities of Pusan and Pohang to the major industrialized cities of Taegu, Taejon, Seoul, and Uijongbu. The operational aspects of this pipeline are included in the mutual defense treaties between Korea and the United States.[20]

The railroad system in Korea is government-owned and is operated by the Korean National Railroad Ltd. It is responsible for 47 percent of cargo shipped inland in Korea and almost all petroleum distributed from the pipeline storage terminals. The railroad system connects all ports with over 6000 kilometers of rail and the nation has an inventory of over 18,000 freight and tank cars. Additionally, the railroad, through subsidiaries, provides an efficient AMTRAC-style passenger service.[19]

Air transportation in Korea has been well-developed with two large international airports, 8 domestic airports,

and numerous U. S. Army airfields, Air Force bases, and Korean Air Force bases. Table 4-6 shows the locations of the commercial airports in South Korea.[19] The Korean Airlines is the only civil airline in Korea and was government-owned until 1969. It is now owned by the Han Jin Transportation conglomerate and has international flights to Japan, the United States, Europe, and the Middle East.[19]

Table 4-6. Airports in South Korea

Seoul*	Chinju	Suwon	Masan*
Cheju	Inchon	Pusan	Taegu
Kangmung	Kwangju	Pohang	Kunsan
Chinhae	Taejon		

*Largest Airports.

Source: South Korea: A Country Study, Washington, D. C., 1982.

MINING, PROCESSING, AND MANUFACTURING

For the most part, mining in Korea is not considered to be a technically developed industry. Mining methods range from large open pit mines with fairly modern escavation equipment to small family mining operations using human and animal labor. In many cases, ore is carried out of the mines in buckets or back carriers.[9] Because of the poor economies of scale, many inefficiencies exist in the mining industry of this country. Korea does not have the capability to process raw materials prior to exporting them. Most of the minerals produced in the country's mines are processed only by crushing and concentrating. Nearly all exports of lead, zinc, silver, manganese, molybdenum, and tungsten are exported as ores and

concentrates. A large portion of the remaining minerals are exported as oxides and hydroxides.[21]

INTERNATIONAL TRADE

With a very poor mineral resource base, Korea has been import-dependent for many mineral commodities and the backbone of the economy has been the manufacturing and petrochemicals industries, both large consumers of raw materials. Mineral fuels make up the largest share of imports in Korea, followed by machines, equipment, and raw materials. A large portion of the Korean economy is based on export commodities, with textiles, fibers, iron and steel, and electronics being the most important.

For a detailed overview of exports and imports of mineral commodities in South Korea, and trading partners, see to Tables 4-7 and 4-8, respectively.

MINERAL COMMODITY ANALYSIS

In terms of world output, the Republic of Korea is a significant producer of graphite, kaolin clay, talc, and tungsten. Although anthracite coal is the most important mineral in volume and value of output, production has averaged only 18 million tons per year over the past ten years. There is also limited domestic mine output of copper, fluorite, gold, iron ore, lead, silver, and zinc.

Table 4-7. Principal Mineral Exports, 1981
(Metric Tons)

Metals	Quantity	Trading Partner(s)
Aluminum	37,033	Saudi Arabia
		Kuwait
Copper	13,231	Indonesia
		Japan
		Saudi Arabia
Tungsten	7,016	Sweden
Non-Metals	**Quantity**	**Trading Partner(s)**
Clays	203,904	United States
		Japan
Fertilizers	750,707	Indonesia
		Philippines
		Turkey
		Thailand
		Taiwan
Graphite	34,348	Japan
		Taiwan
Gypsum	160,884	Japan
		Taiwan
		Hong Kong
Stone, Sand, and Gravel	472,310	Japan
Talc	50,444	Japan
		Thailand
		Philippines
Mineral Fuels	**Quantity**	**Trading Partner(s)**
Refined Petroleum (Barrels)	42,632,000	East Asian Countries

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

Table 4-8. Principal Mineral Imports, 1981
(Metric Tons)

Metals	Quantity	Trading Partner(s)
Aluminum	187,582	Japan United States Canada
Copper	454,977	Philippines Chile Canada United States
Iron and Steel	16,844,589	Australia India Peru Japan United States
Lead	44,797	Singapore Peru Taiwan
Manganese	283,217	Australia India Gabon
Titanium	31,268	Malaysia Australia
Zinc	102,927	United States Peru
Non-Metals	**Quantity**	**Trading Partner(s)**
Asbestos	53,787	Canada United States
Clays	836,002	Japan United States
Fertilizers	1,350,000	Canada Belgium
Salt	970,242	Australia Japan
Sulfur	386,909	Canada Japan
Mineral Fuels	**Quantity**	**Trading Partner(s)**
Coal	12,571,775	United States Australia Canada
Petroleum (Barrels)	199,149,000	Saudi Arabia Kuwait

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

Since Korea is considered poor in terms of mineral resources, the country has accumulated huge trade deficits to maintain the industrial sectors. In 1982, Korea was over 85 percent import-dependent for energy, metals, and minerals.[21] Table 4-9 shows, at a glance, the import-dependence position of the Republic of Korea for many of its essential minerals.

The next few sections of this chapter expound on the imports, production, exports, development, trends, and potential of the important mineral commodities in the Republic of Korea.

ENERGY MINERALS

PETROLEUM

The Republic of Korea does not have any discovered petroleum reserves and is entirely dependent upon imported oil for its industries. About 75 percent of total energy consumption in 1982 was imported.[21] In the early 1960's, petroleum accounted for one-fifth of all imports; now it represents one-fourth.[9] Although oil imports have been steadily increasing in the past 20 years, a large portion of these imports are refined and exported.[9] Initially the United States and Japan were the major suppliers, but in 1965, Korea and Kuwait entered into a 15 year contract agreement. Presently, Saudi Arabia supplies 60 percent of crude oil imports and Kuwait supplies 27 percent. Nearly all domestic petroleum production is refinery production from imported crude oil, and is almost all produced by the Ulsan Oil Corporation, a 50 percent government-

Table 4-9. Commodity Imports, Production, Exports, and Import Dependence (Units are in Metric Tons Unless Otherwise Specified).

Commodity	Imports	Production	Exports	Import Dependence
Aluminum	187,582	15,226*	37,033	100
Antimony	652	0	20	100
Chromium	4,732	0	0	100
Cobalt	62	0	0	100
Copper	454,977	167,091*	13,231	100
Gold (Troy Ounces)	0	55,750	11,287	0
Iron and Steel (1000 Metric Tons)	16,845	21,187*	10,963	80
Lead	44,797	26,390*	8,613	77
Magnesium	405	0	32	100
Manganese	283,217	0	0	100
Molybdenum	7	361	651	0
Nickel	4,492	0	43	100
Silver (1000 Troy Ounces)	335	1,444	1,711	0
Tin	2,306	0	28	100
Titanium	31,268	0	0	100
Tungsten	19	2,233	7,016	0
Zinc	102,927	158,281*	12,751	39
Asbestos	53,787	15,933	40	77
Cement (1000 Tons)	7,003**	17,887	6,635	0
Clays	836,002	174,918	203,904	83
Feldspar/Fluorspar	23,128	88,707	18,538	21
Fertilizers	1,350,000	279,172*	750,707	100
Graphite	205	20,965	34,348	0
Gypsum	741	0	160,884	0
Salt	970,242	864,000	11,711	53
Sulfur	386,909	0	1,409	100
Talc	1,789	591,117	50,444	0
Coal (1000 Tons)	12,573	18,382	0	41
Petroleum (1000 Barrels)	199,149	178,369*	42,632	100

* Production from imported raw materials.
**Normal imports are about 5,000 tons.

Source: Minerals Yearbook, U. S. Bureau of Mines, 1982 Reprint.

owned corporation. Refineries in South Korea are located at Ulsan, Pusan, Yosu, and Inchon. Figure 4-1 shows annual production, imports, and exports of petroleum in South Korea.

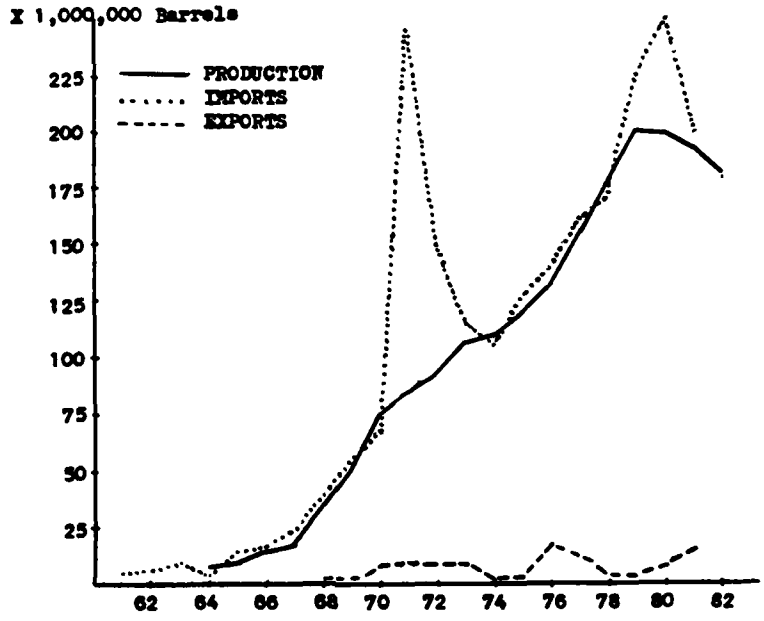


Figure 4-1: Annual Production, Imports, and Exports of Petroleum in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

Oil exploration in South Korea has been extensive for over 25 years.[9] In 1967, test wells in the Pohang Basin were drilled with no production.[24] In 1972, exploration and drilling began in the Yellow Sea, the Sea of Japan, and the East China Sea.[25] Presently, nearly all of the shelf area around Korea is either being explored or is up for bid for exploration. Several U. S. corporations including Zapato Exploration, Inc., Texaco Korea, Inc., and the Korean American Oil Co., Inc. are conducting seismic tests with promising signs of offshore oil or gas. Drilling is expected to begin by 1986.[26]

NATURAL GAS

Natural gas in Korea is virtually nonexistent with no proven reserves anywhere. The government is negotiating a long-term purchase contract with Indonesia for liquified natural gas at the rate of 1.5 million tons per year beginning in 1985. A receiving terminal is proposed near Pyongtaek, south of Seoul, with pipelines to Seoul and Inchon. The estimated cost of this project is $785 million, and included in the contract is a 50-50 joint venture between Korea and Indonesia in exploration and production.[27]

COAL

Anthracite coal is the only indigenous fossil fuel in Korea and it accounts for about one-fifth of the nation's energy consumption, but with its antiquated coal mining methods, Korea has not been able to increase production at a sufficient rate to meet increasing demands. Korea was a net exporter in the 1960's and early 1970's, but is now a net importer.[9] Production of coal in Korea has increased steadily in the past 20 years, at a rate of 7 percent annually until 1976, and then at a faster rate beginning in 1976 because of increasing oil prices and the government's coal expansion programs.[9] Annual production and imports of coal in Korea are shown in Figure 4-2.

Most of the coal in Korea is powdery, difficult to mine, and expensive to transport from remote mining locations to consumption centers. The heat content of the coal is an average of 28 million BTU's per ton, and is used for a variety

of purposes.[10] The coal industry has been plagued with problems of bankruptcy and worker unrest due to safety hazards. Much of Korea's coal is used in the form of briquettes for heating and cooking in middle and low income homes.[20] The government has regulated the price of these briquettes and by doing so, has virtually restricted the capital needed for expansion in the coal industry. Another serious problem in the coal industry is the inadequate transportation network from the small mines to consumption centers.[10]

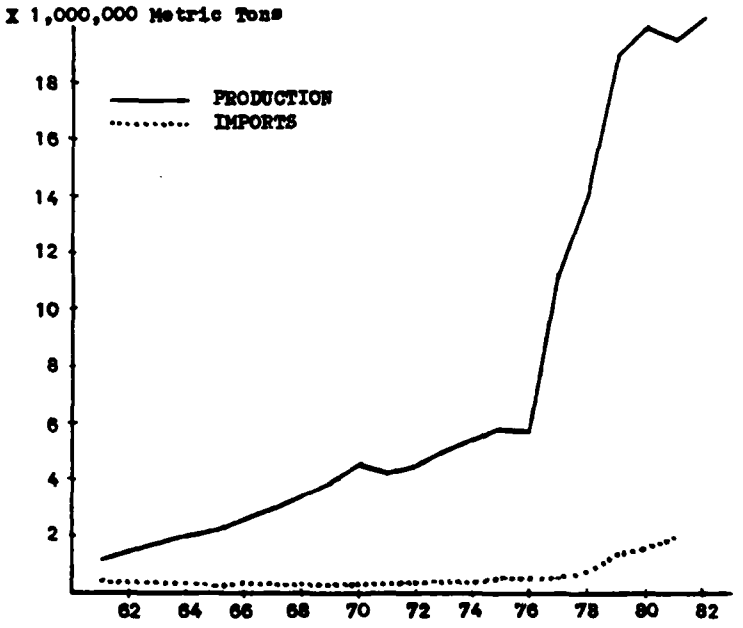


Figure 4-2: Annual Production and Imports of Coal in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

Coal consumption in Korea is expected to increase 11.1 percent annually until 1986, reaching 35 percent of the total energy mix by that year. Production in 1981 peaked at almost 20 million tons with the Dai Han Coal Corp. (government-owned)

producing nearly 5 million tons and over 86 private companies contributing the rest.[28] Even with the increases in production, coal exports ceased in 1978.[29]

South Korea has begun an aggressive program to ensure future coal supplies will be available. Dai Han Coal Corp. is the country's sole importer and has invested in foreign ventures to include Mount Thorley Coal Mine in Australia, the Tanoma Mine in the United States, and the Greenhill Mine in Canada. Shipments are already arriving in Korea from these ventures.[28]

METALLIC MINERALS

COBALT

Although not a significant consumer, South Korea is completely dependent upon imports to meet its cobalt requirements. Cobalt imports peaked in 1979 at 86 tons, and imports in 1981 amounted to 54 tons, primarily from Zaire and Japan. Figure 4-3 shows the import patterns of cobalt into Korea.

CHROMIUM

Korea is completely dependent upon imports for its chromium supplies as well. Chromium ore and concentrate and oxides and hydroxides are imported from the Philippines, Japan, and the United States. To compensate for total import-dependence, it is standard practice to install poor quality, thinly layered chrome on automobiles, appliances, and bicycles, which produces an esthetic effect when new, and then corrodes shortly thereafter.[20] Figure 4-4 shows the chromium import trends in

Korea. The large decrease in imports beginning in 1980 was caused by the manufacturing conservation practices mentioned above.

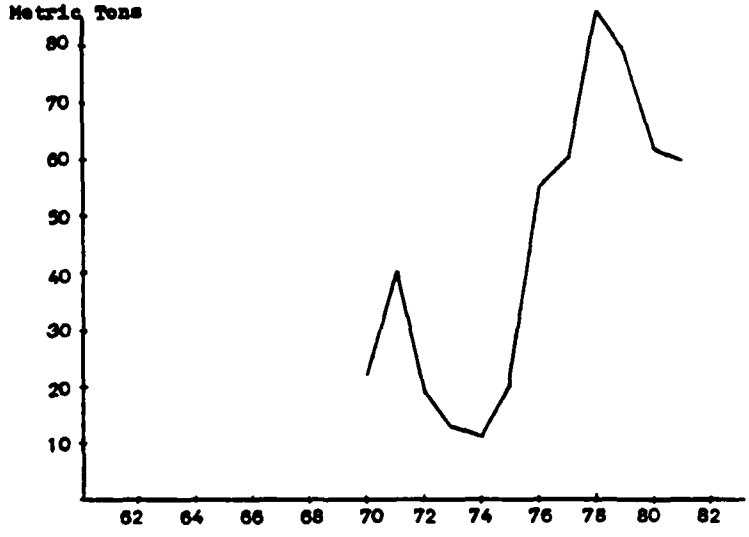


Figure 4-3: Annual Cobalt Imports in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

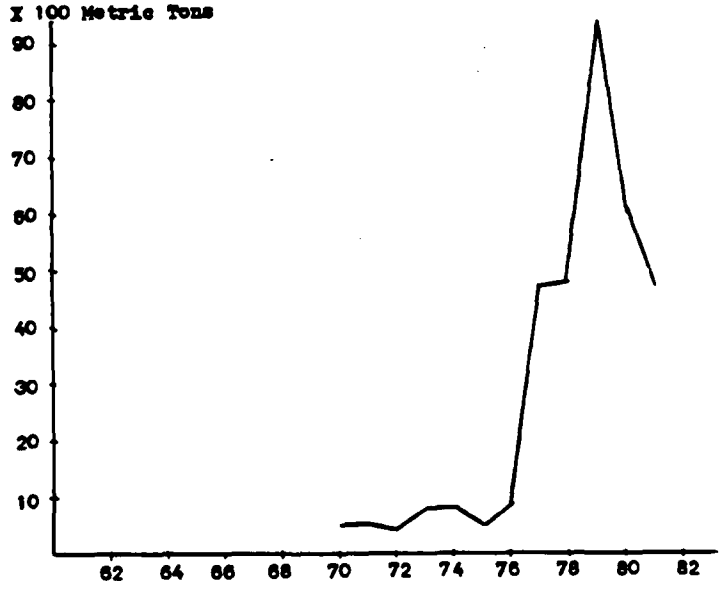


Figure 4-4: Annual Imports of Chromium (Ore and Concentrates, Oxides and Hydroxides) in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

IRON AND STEEL

Iron ore reserves in Korea were established at 112 million tons in 1970, but only 18 million tons were economically mineable.[19] This is a major reason why iron ore production has not increased as demands have increased. Figure 4-5 shows annual production, imports, and exports of iron ore in Korea.

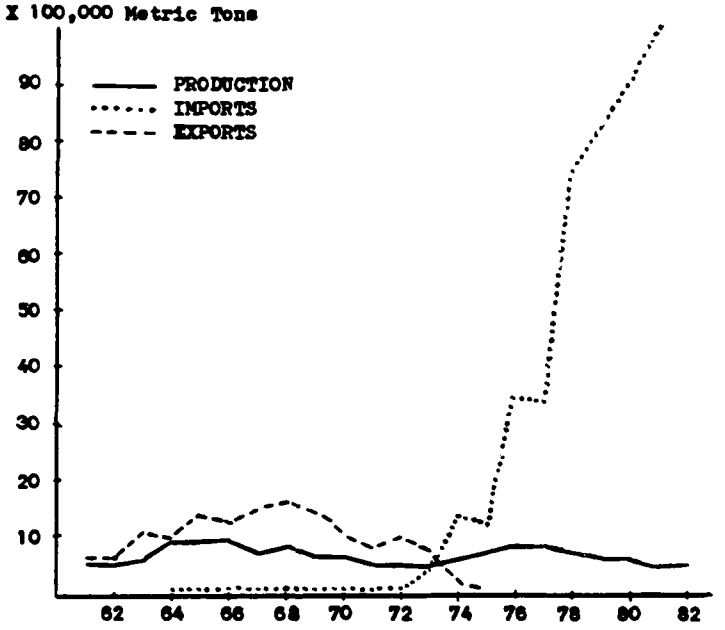


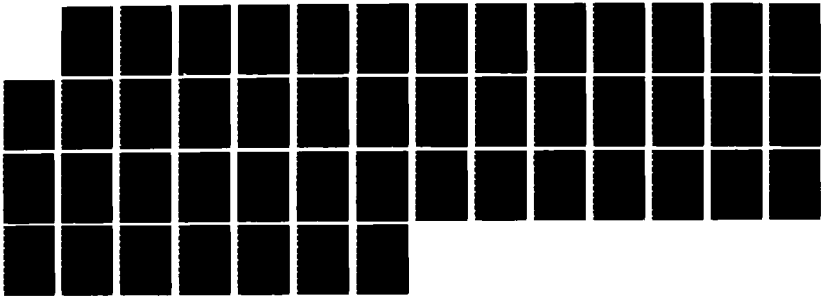
Figure 4-5: Annual Production, Imports, and Exports of Iron Ore in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

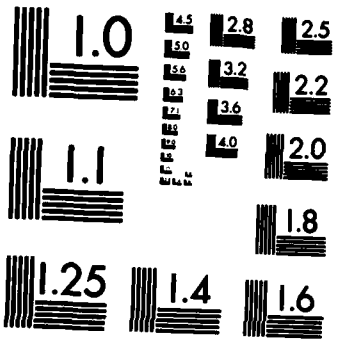
The Pohang Iron and Steel Co. Ltd., a state-run enterprise, has dominated the steel industry for nearly 15 years. It has the only integrated steelmaking facility in the country, located at Pohang. Other major iron and steel centers are in Pusan, Taegu, Masan, Seoul, Sam Cheok, and Ulsan. Total iron and steel production in 1982 was over 20 million tons.

Exports of iron and steel from South Korea have been

AD-A172 269 AN ANALYSIS OF THE MINERAL INDUSTRIES OF THE REPUBLICS 3/3
OFCCHINA THE PHILI (U) RRMY MILITARY PERSONNEL CENTER
ALEXANDRIA VA P C SPINLER DEC 84

UNCLASSIFIED F/G 5/3 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

dramatically increasing since 1970. In 1981, the steel exports more than doubled from 1980, climbing to nearly 11 million tons. Primary exports included pig iron, primary steel, bars, rods and shapes, plates and sheets, and tubes and pipes.[21] Exports of steel are to other Asian countries, North America, the Middle East, and to other areas.[21] Korea exported over $31.2 million of plate steel to the United States in 1983, which sparked widespread criticism and a ruling by the International Trade Commission that the Korean steel exports to the U. S. is hurting the U. S. steel producers.[30]

Even though Korea depends upon imported energy and iron ore, the steel industry is thriving and growing. Construction of the nation's second integrated iron and steel complex is expected to begin in July 1985 in the coastal city of Kuangyang, near Yosu, with an initial capacity of over 3 million tons of crude steel and with a second stage expansion to 6 million tons by 1990.[28] Figure 4-6 shows annual production, imports, and exports of iron and steel in Korea.

MANGANESE

Manganese deposits in South Korea are located in the south and central parts of the country, and are believed to have developed in Pre-Cambrian and Paleozoic times in dolostone and limestone beds as hydrothermal replacement deposits, sedimentary deposits, hydrothermal veins, residual deposits, and metamorphic deposits. As a result, the reserves of manganese include rhodochrosite, rhodonite, and pyrolusite.[7]

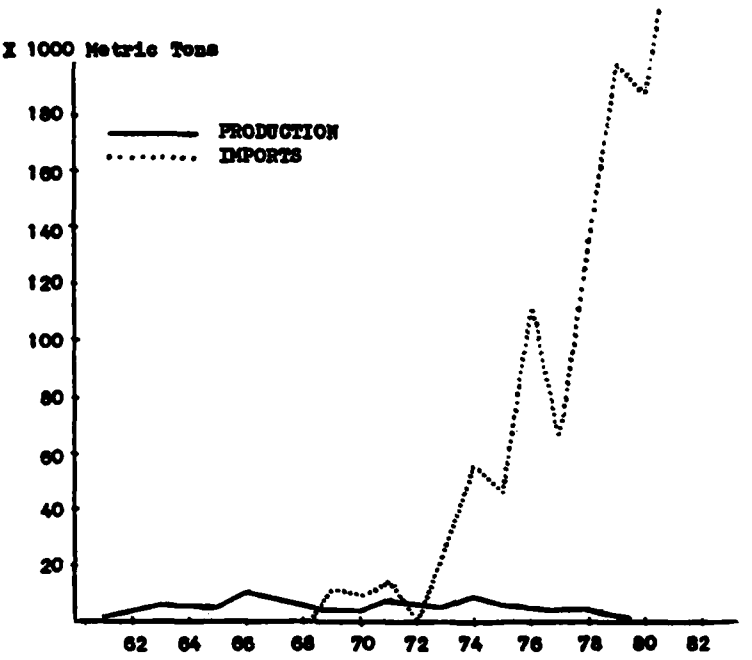


Figure 4-7: Annual Production and Imports of Manganese in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

MOLYBDENUM

Molybdenite occurs in South Korea in several porphyry deposits on the west side of the peninsula and, until recently, was almost exclusively mined as a byproduct of tungsten. Korea has been a net exporter of molybdenum ore and concentrate, exporting nearly all of its production, except in 1971 when a large shipment of ore and concentrate was imported from the United States to meet export contracts, much the same situation as occurred in the Philippines during the same time.[25] Since molybdenum was produced as a byproduct of tungsten in Korea, the reduced levels of tungsten production from 1971 to 1977 resulted in suspending molybdenum extraction from tungsten ores. This had a devastating effect on the molybdenum export situation, but in 1975, production and exports of molybdenum

have recovered and increased significantly. Korea exports to Canada, the United Kingdom, and West Germany.

Figure 4-8 shows the patterns of molybdenum production, imports, and exports in Korea. Although the production in 1982 was only 361 tons, it will likely increase in the future. Korea's largest molybdenum deposit was discovered in 1980, at the Sangdong Mine in the Kwangwon Province, 130 kilometers southeast of Seoul. The deposit was estimated to contain 80 million tons of 0.41 percent ore.[11] Now molybdenum is produced more as a primary mineral than as a secondary byproduct. In 1982 and 1983, molybdenum prices declined sharply and many small mines ceased operations because of unprofitability, so production, at least for the short term, is expected to continue to be at reduced levels.[31]

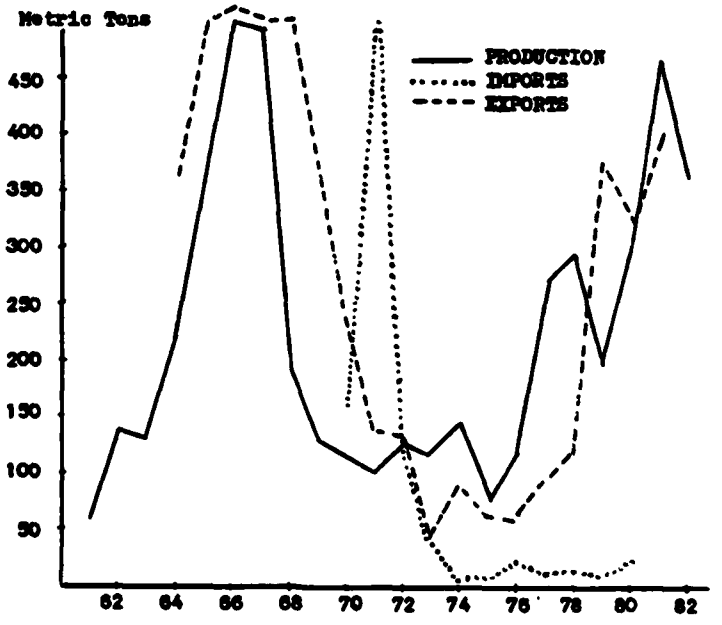


Figure 4-8: Annual Production, Imports, and Exports of Molybdenum in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

NICKEL

Korea was a net exporter of nickel prior to the mid-1960's, but due to the depletion of nickel ore reserves in 1965, exports were stopped. Figure 4-9 shows the rapidly rising imports and the declining production and exports of nickel in Korea. Nickel is not processed in Korea, so all imports are in the form of metals, oxides, and hydroxides. Korea's main import sources are Japan and the United States.

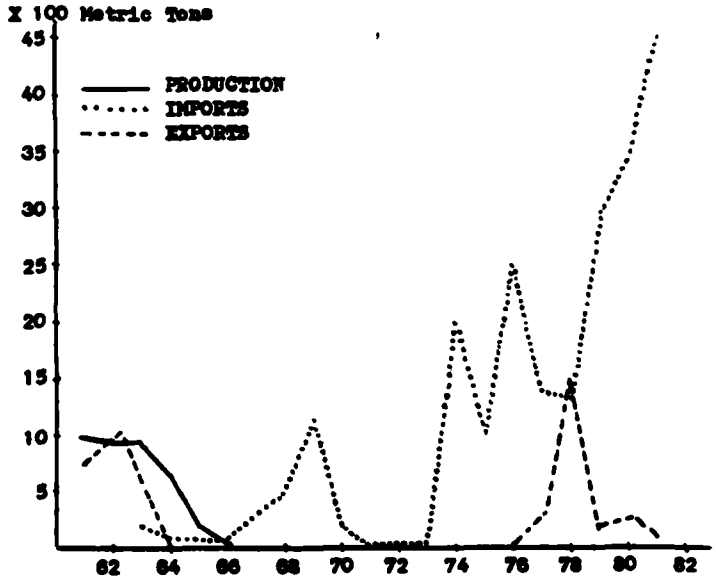


Figure 4-9: Annual Production, Imports, and Exports of Nickel in the Republic of Korea, 1961-1982. Source: Mineral Yearbook, U. S. Bureau of Mines.

TUNGSTEN

Tungsten in South Korea occurs as scheelite in porphyry deposits in the western side of the country near Taejon, and has important byproducts of bismuth and molybdenum.[22] South Korea is an important producer of tungsten, contributing 8 percent of world production. The Sangdong Mine of the Korean

Mining Co. Ltd., a state-run enterprise, accounts for over 90 percent of total production. The remainder of production comes from numerous smaller tungsten mining companies. All tungsten concentrate is shipped to a processing plant in Taegu, operated by Korea Tungsten Ltd., where it is processed to produce scheelite concentrate, tungsten powder, and ammonium perratungstate (synthetic scheelite), nearly all for export.[31] In 1982, a new ore-dressing plant was dedicated with a capacity of 500 tons per day, so Korea's tungsten output can be expected to increase as this plant begins full production.[21] Figure 4-10 shows the tungsten production and export patterns in Korea. The large increase in exports in 1970 reflects a shipment of 8000 tons of ore to Japan. The curves show a decline in volume from the early 1960's, but in actuality, a shift from ore and concentrate to tungsten powder and metal, which is included in the graph, is responsible for the curve's shape.[9]

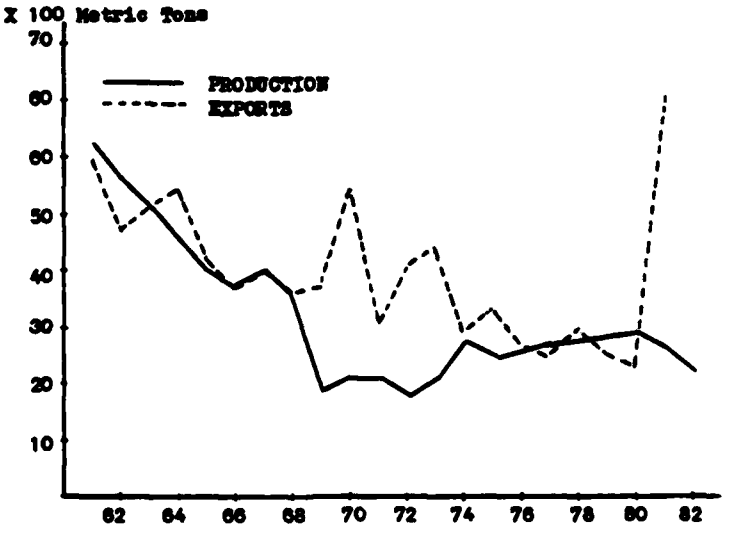


Figure 4-10: Annual Production and Exports of Tungsten in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

ALUMINUM

Aluminum of Korea Ltd., a company jointly owned by Hyunai Heavy Industries Ltd., of Korea, and by Pechiney Ugine Kuhlmann of France, operates the only aluminum refinery in the country, a 17,500 ton-per-year plant at Ulsan. All of the refinery's requirement for alumina is imported from Japan as ore and concentrate and oxides and hydroxides. The Korean Industrial Bank is currently negotiating with France for possible expansion of the Ulsan smelter to 40,000 tons-per-year capacity by 1985. This new smelter would use alumina from India and would be designed for eventual expansion to 200,000 tons-per-year capacity.[29] Another joint venture between Korea and Australia was postponed because of the political crisis caused by the Rangoon bombing incident in 1983. President Chun Doo Hwan was forced to reschedule the official ceremonies to begin the project. When completed, the aluminum smelting capacity of South Korea will be increased 20 percent, and will use coal from Australia for fuel.[32]

The domestic demand for aluminum in Korea has been increasing steadily, reaching 150,000 tons in 1980 and then falling to 100,000 tons in 1982. Korea must import aluminum metal to meet demands even though the aluminum production has been at capacity for the past 20 years.[9] Korea's exports of aluminum are semimanufactures, which are shipped to Saudi Arabia, as an exchange for oil. Figure 4-11 shows the annual production, imports, and exports of aluminum in Korea.

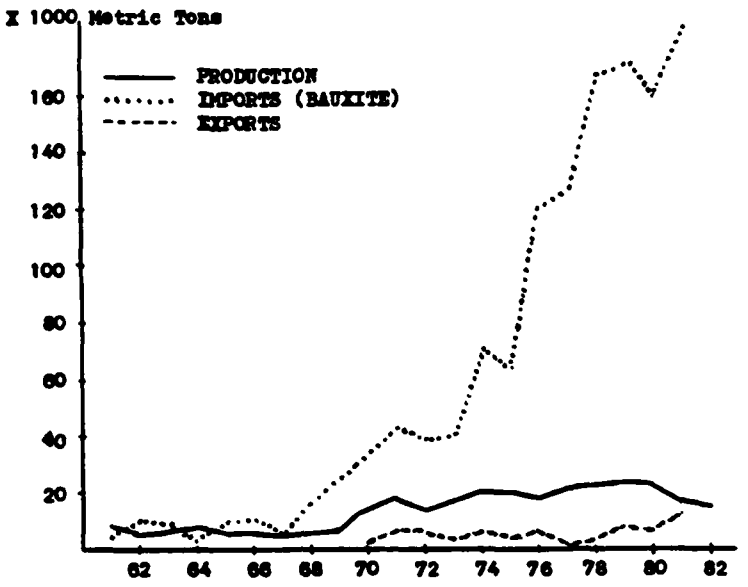


Figure 4-11: Annual Production, Imports, and Exports of Aluminum in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

MAGNESIUM

Korea is totally dependent upon imports for magnesium supplies. Domestic sources were mined in the early 1970's, but they have been abandoned because they could not compete with other sources.[9] Magnesium is imported as scrap and semi-manufactures, primarily from the United States. Figure 4-12 shows the erratic trends of magnesium imports, largely due to purchasing on the spot market in small increments.[9]

COPPER

Korea has limited copper reserves, operating only 3 mines; the Dalsang Mine, the Kunbuk Mine, and the Il Kwang Mine, all north of Pusan. Annual output of copper ore from these mines is quite insignificant, peaking in 1966.

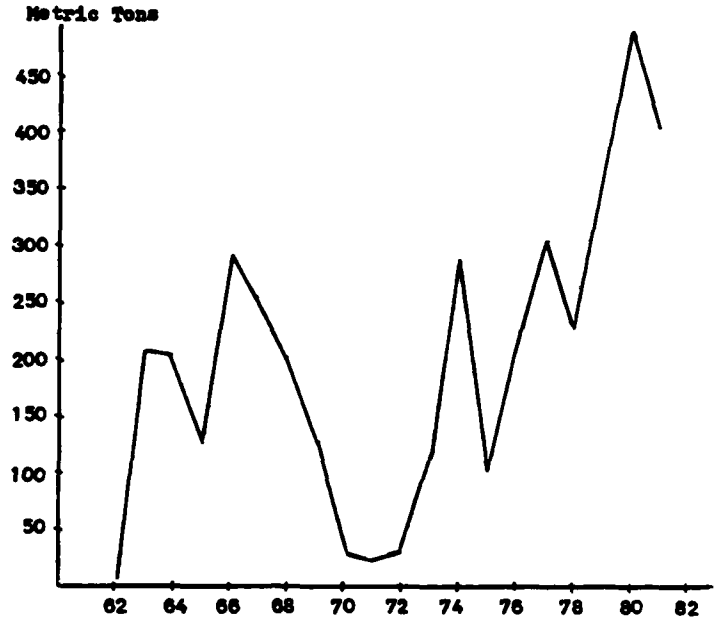


Figure 4-12: Annual Magnesium Imports in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

South Korea has two copper refineries, both consuming imported copper concentrate. Production of copper is by the Korean Mining and Smelting Co. Ltd., located at Changchang, with a capacity of 40,000 tons per year, and by the Onsan Copper Refinery Co. Ltd., in Onsan, with a capacity of 80,000 tons.[21] Annual domestic demand for copper was 150,000 tons in 1982.[21] Copper scrap and unwrought copper metal were imported to satisfy the needs of the country. Figure 4-13 shows the annual production, imports, and exports of copper in Korea. It can be inferred from this graph that the two smelters are relatively new; the Korean Mining smelter was commissioned in 1975, and the Onsan Copper refinery was opened in 1979.[11]

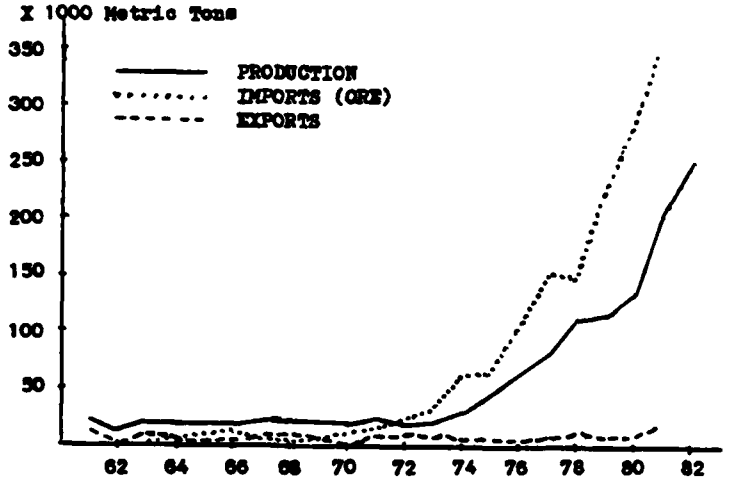


Figure 4-13: Annual Production, Imports, and Exports of Copper in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

LEAD AND ZINC

The Young Poong Mining Co. Ltd. is the largest lead and zinc producer in South Korea, operating mines at Yeonhua, Boonpyong, and Ulgen. Young Poong produces all of the country's output of lead concentrate and almost all of the output of zinc.[28] Lead and zinc occur in South Korea in a wide contact metamorphosed zone of shales and limestones. The distribution of the deposits was controlled by faults and bedding planes. Magnetite, sphalerite, galena, and chalcopyrite occur along a long body running east-west in the southern part of the country.[33] The Ulchin Mine Area, in Kyongsang-Pukdo Province, also contains large ore bodies of lead, zinc, and copper in skarn zones embedded in limestone.[8]

Lead output from copper-lead-zinc and lead-zinc ore in the Kyungsang Mine averages about 11,500 metric tons per year. Lead metal is also recovered as a byproduct of copper by the

Korea Mining and Smelting Co. Ltd., which has a capacity to produce 12,000 tons of lead per year.[28] Annual consumption of lead in Korea is about 50,000 tons, of which about 85 percent is imported as scrap metal, mostly from the United States, and as unwrought metal from Mexico, Japan, Peru, and the U. S. Lead is exported mostly as ore and concentrate to Japan for further processing. Production has been nearly at capacity since 1966 with a total production in 1982 of 10,296 tons of metal from the mines, and 16,094 tons of metal from smelters.[21] Annual production, imports, and exports of lead in Korea are shown in Figure 4-14. Production has been somewhat stagnant because of low-grade ore, but the government is still considering expanding the production capacity to ease import-dependence.

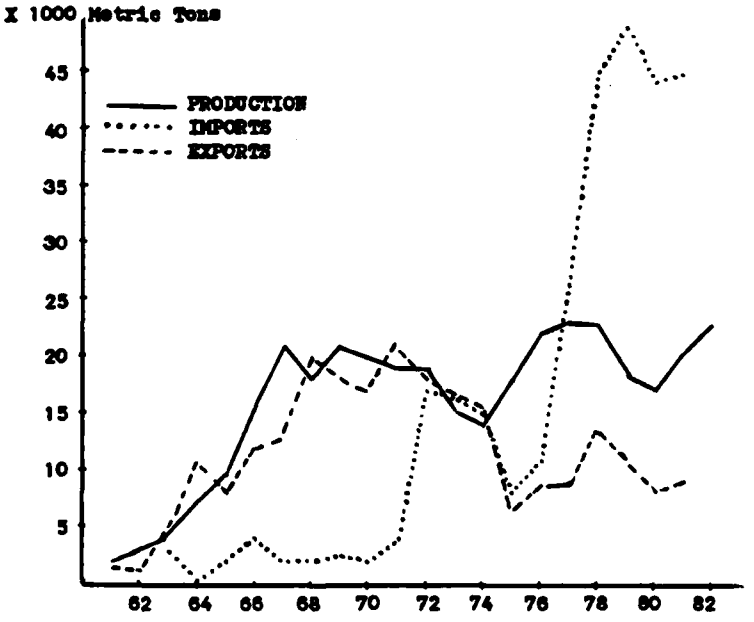


Figure 4-14: Annual Production, Imports, and Exports of Lead in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

Zinc is mined from skarn deposits in South Korea using open pit mining methods. Zinc production has steadily risen since 1961, but mine output has not been able to increase as fast as refinery capacity during the same period. In 1982, total metal production was over 140,000 tons, of which about 70 percent was produced from ore mined domestically. The Korean Zinc Co. completed a 50,000 ton-per-year refinery at Onsan in 1978, which has greatly reduced the requirement to export zinc ore and concentrate to Japan for processing. In 1981, a lead-zinc deposit was discovered in the Kyongsang-Pukdo Province in the Uchin Mine Area, 220 kilometers southeast of Seoul. The deposit has an estimated 6.3 million tons of ore and will significantly enhance the domestic production of lead and zinc in Korea.[28] Figure 4-15 shows annual production, imports, and exports of zinc in Korea.

TIN

Korea is almost 100 percent import-dependent for tin supplies, but the primary purpose of the tin imports is for processing and manufacturing finished products for export.[9] Malaysia, Singapore, and Indonesia are the principal sources of tin imports to Korea, and a small amount of ore is mined domestically. Tin imports are mostly in the form of unwrought metal, but in 1973 and 1974, 4900 and 12,500 metric tons of ore and concentrate, respectively, were imported from Malaysia for processing and stockpiling.[9] Figure 4-16 shows annual production, imports, and exports of tin in Korea.

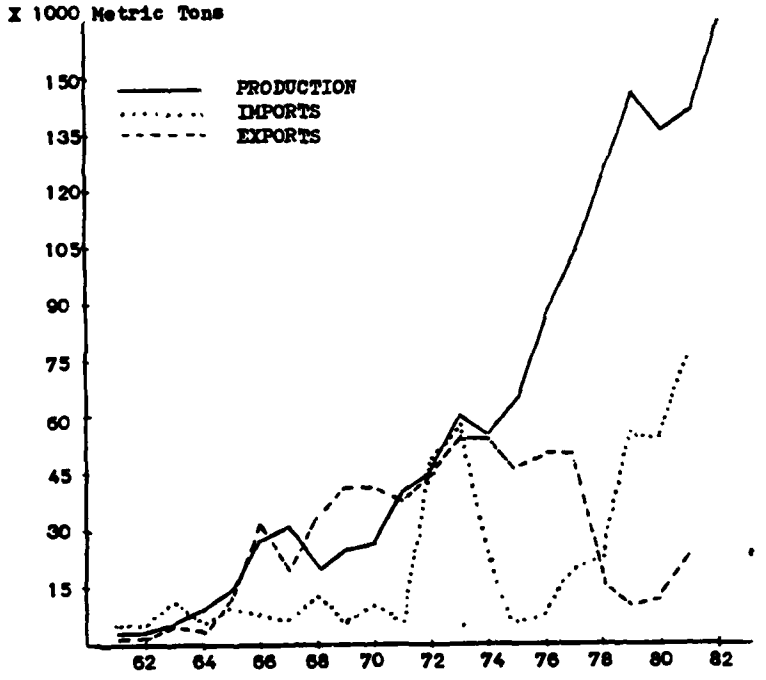


Figure 4-15: Annual Production, Imports, and Exports of Zinc in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

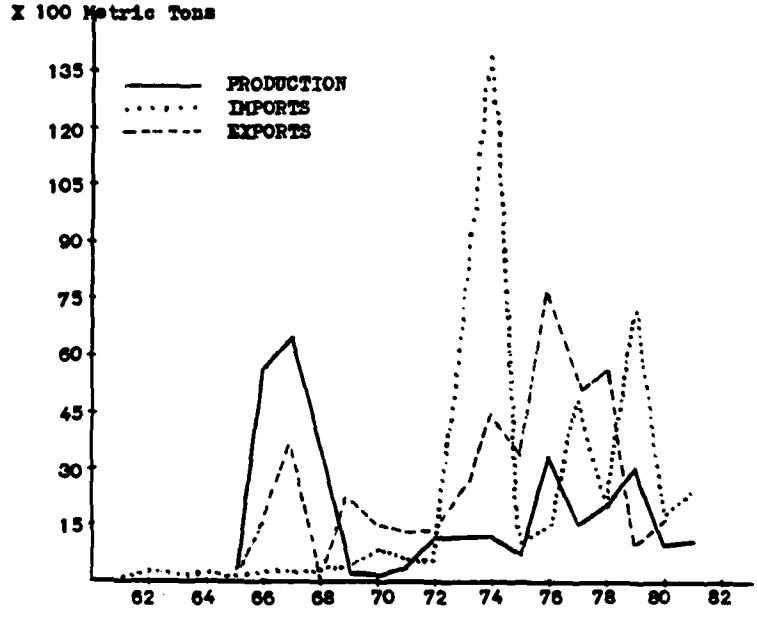


Figure 4-16: Annual Production, Imports, and Exports of Tin in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

ANTIMONY

South Korea has only modest deposits of stibnite, and the majority of the antimony required is imported from Thailand as ore and concentrate. Figure 4-17 shows the annual production and imports of antimony in Korea.

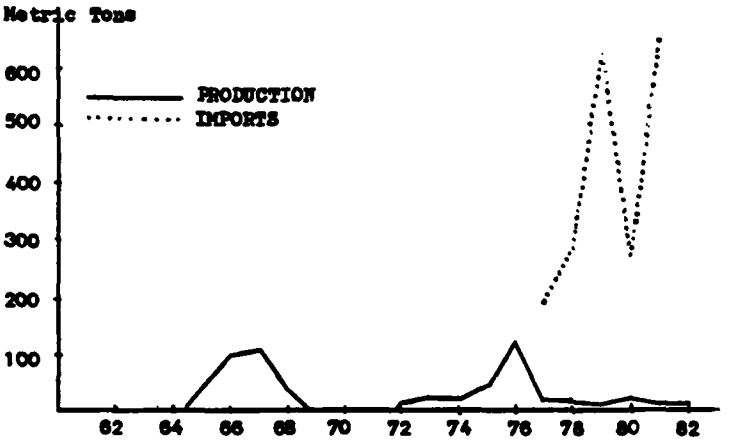


Figure 4-17: Annual Production and Imports of Antimony in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

BISMUTH

South Korea is self-sufficient and a net exporter of bismuth on a modest scale. The entire output of bismuth is recovered as a byproduct of processing tungsten ore from the Sangdong Mine.[9] Korea Tungsten Mining Co. operates a bismuth refinery in conjunction with the tungsten beneficiation plants to produce refined bismuth.[31] With the decline in tungsten production in the 1960's, as discussed earlier, bismuth production also decreased significantly. Bismuth stocks were very large in Korea, and with production falling in the 1960's, these stocks, amounting to over 2000 tons, were exported to the

United States in 1973. Figure 4-18 shows annual bismuth production and exports in South Korea.

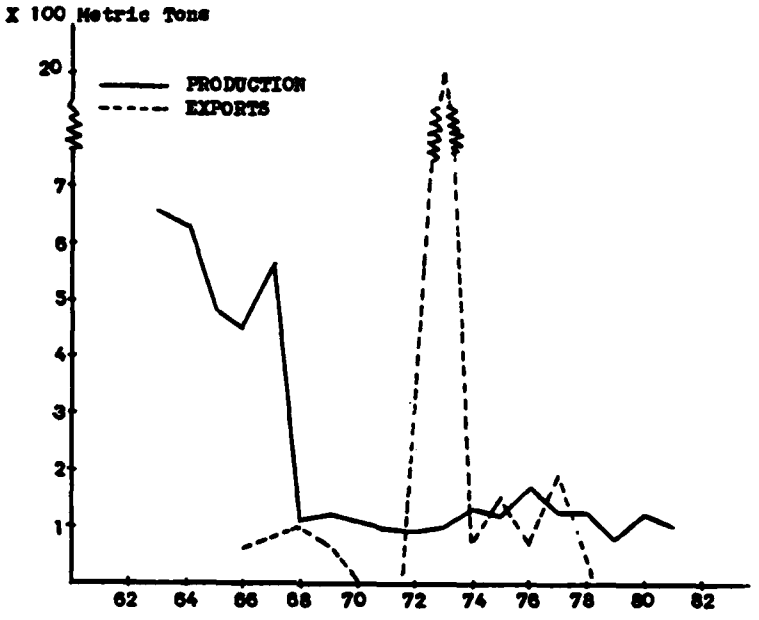


Figure 4-18: Annual Production and Exports of Bismuth in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

TITANIUM

Titanium consumption in Korea has been steadily increasing in the past two decades. Korea has no domestic supplies of titanium, so rutile is all imported from Australia, but the bulk of titanium imports (80-90 %) is ilmenite, which is imported from Malaysia.[9] Most titanium in South Korea is used for pigment manufacturing. Figure 4-19 shows annual titanium imports in the Republic of Korea.

VANADIUM

Consumption of vanadium in Korea has developed very recently, and since there is no domestic source, Korea must

import all of its vanadium, primarily from the United States and Japan. Imports of vanadium are as pentoxides, oxides, and hydroxides for use in the steel industry. These imports have been on a small scale except in 1977 when Korea imported 80 tons from Japan for a stockpile.[9] Figure 4-20 shows vanadium imports in South Korea.

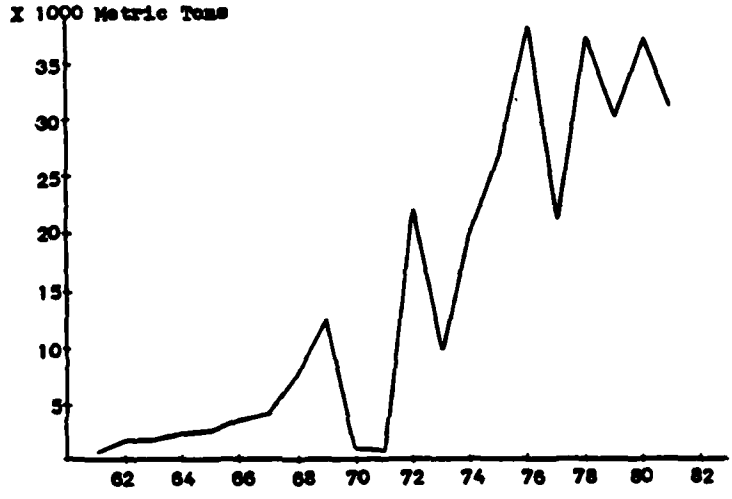


Figure 4-19: Annual Titanium Imports in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

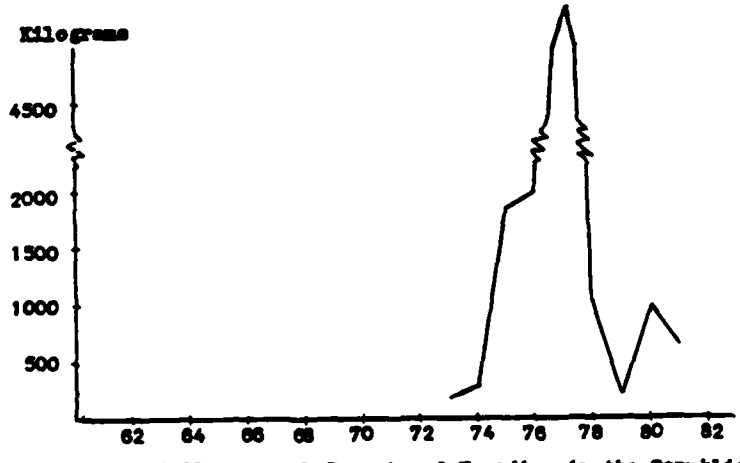


Figure 4-20: Annual Imports of Vanadium in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

ZIRCONIUM

The use of zirconium in the steel industry in Korea began in 1969, like other steel alloys in Korea, and its use has grown rapidly in recent years as the quality of Korean steel has been improved. Since Korea has no domestic supplies of zircon, ore and concentrate is imported from Australia, Japan, and Malaysia.[9] Figure 4-21 shows the import patterns of zirconium in Korea, with imports in 1982 totalling 3123 tons.[21]

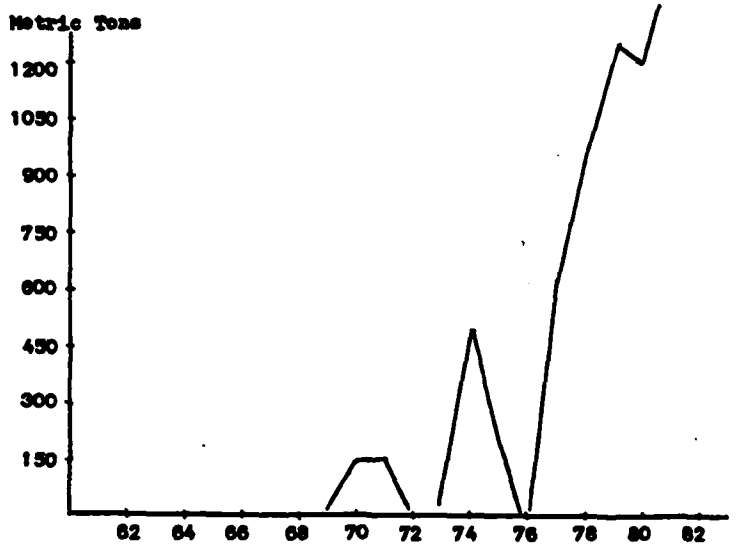


Figure 4-21: Annual Zirconium Imports in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GOLD

Korea is considered to be self-sufficient in gold, which is presently nearly all produced by Korea Mining and Smelting Co. Ltd., as a byproduct of copper, and because of its byproduct relationship with copper, gold production is following the same upward trend that copper is. Prior to 1970, gold was

mined as a primary ore from lode-type mines in Kwangwondo Province. Gold production in 1982 totalled 55,750 troy ounces, but this is still only one-half of the production level attained in 1962, before the primary gold deposits were depleted.[9] Figure 4-22 shows the annual gold production in Korea. Because of the slump in the copper market, Korea has had to import gold beginning in 1977, and will probably continue to import gold until the copper industry expands sufficiently to increase the gold output to a level that will satisfy demand.

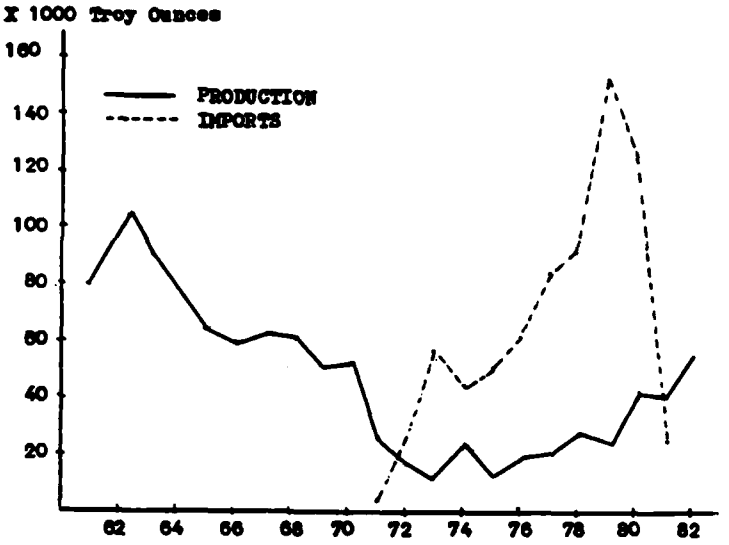


Figure 4-22: Annual Gold Production and Imports in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

SILVER

Korea produces modest amounts of silver as a byproduct of copper and lead production, but since demand exceeds domestic production, Korea has to import about 30 percent of its requirements. Imports and exports of silver have been at a

relatively low level except in 1970 when Korea exported over 33 million troy ounces because of a fear of a severe price decline, and then imported 41 million ounces when the price trend reversed.[25] Japan is the main silver trader with Korea. Figure 4-23 shows the silver production and trade patterns in South Korea. The bulk of silver output in Korea is by the Korean Mining and Smelting Co. Ltd. and by the Young Poong Mining Co.

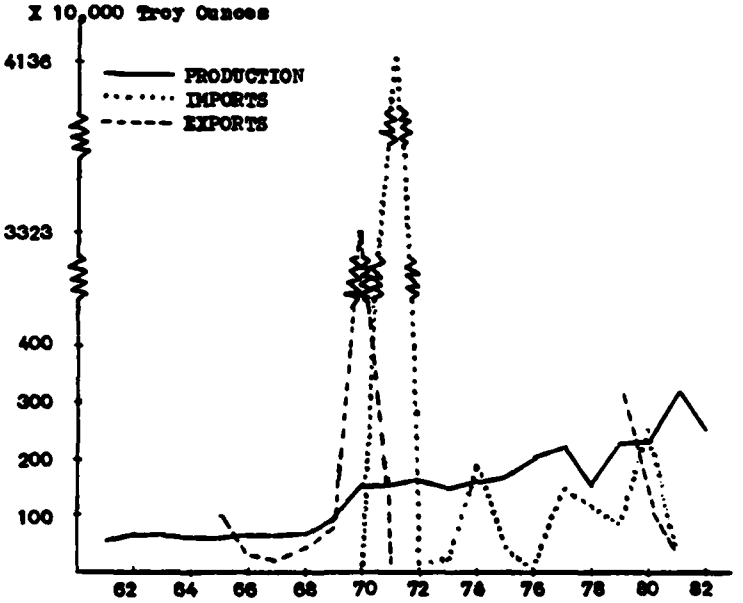


Figure 4-23: Annual Production, Imports, and Exports of Silver in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

PLATINUM GROUP METALS

In 1970, South Korea became a small importer of platinum group metals, importing nearly all of these metals from West Germany. Indications are that sizeable deposits of economic platinum group metals have been discovered recently in the country. In 1977, Korea exported over 1 million troy ounces;

in 1978, exports exceeded 1.7 million ounces; and in 1981, exports were nearly 500,000 troy ounces, all being shipped to the United States.[9] Figure 4-24 shows annual imports and exports of platinum group metals in South Korea. Production statistics are not published.

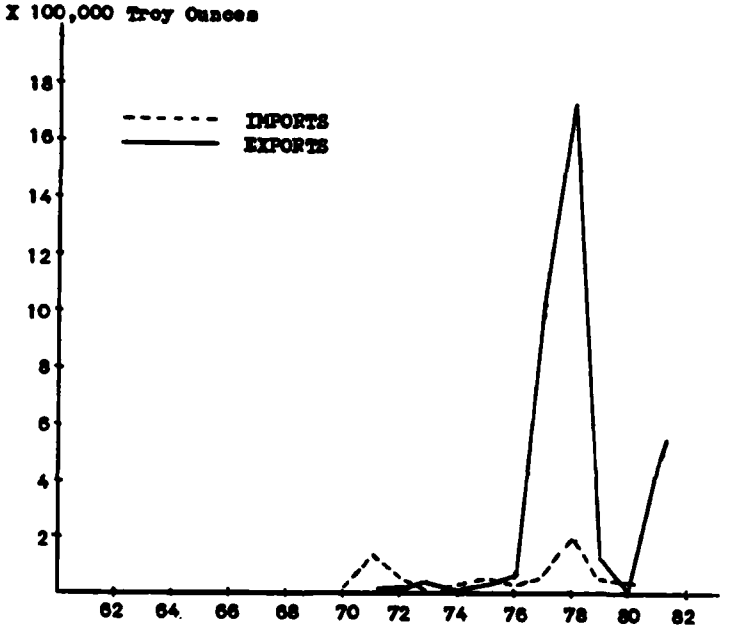


Figure 4-24: Annual Imports and Exports of Platinum Group Metals in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

NON-METALLIC MINERALS

ASBESTOS

The demand for asbestos in South Korea grew very rapidly from 1961-1973, reaching a peak of slightly more than 96,000 tons, but since 1973, demand has been declining due to a reduction in electrical insulation requirements.[9] As a result, imports have been gradually reduced to as low as 37,000 tons in 1980. Production, on the other hand, is slowly increasing,

reaching 16,000 tons in 1982. Figure 4-25 shows the asbestos imports and production patterns in South Korea. If the present trend continues, by the mid-1990's, South Korea could be self-sufficient.

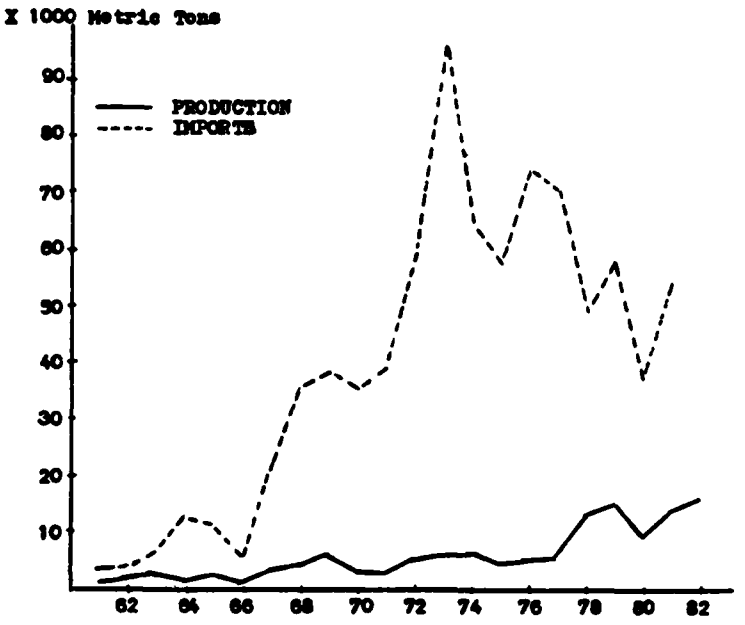


Figure 4-25: Annual Production and Imports of Asbestos in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

BARITE

Barite is used in South Korea in the manufacturing of paper, and domestic production is sufficient to satisfy demand. Barite production has been erratic with two peak production periods followed by slumps as shown in Figure 4-26.[9] The reason for the large barite requirements from 1975 to 1978 was to supply large amounts of drilling mud for oil drilling being conducted offshore around Korea during that time.[9]

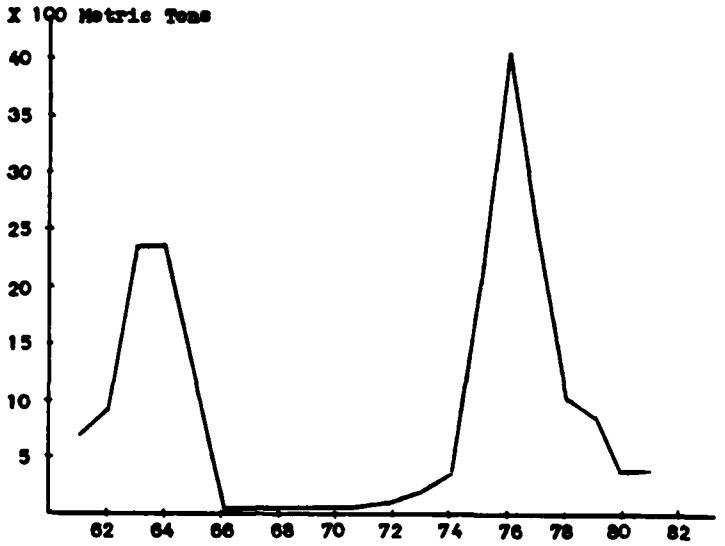


Figure 4-26: Annual Production of Barite in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GRAPHITE

Although annual production of graphite has dropped considerably since the early 1960's, South Korea continues to be a significant producer of graphite in world terms, producing crystalline and amorphous graphite, with over 98 percent of output being amorphous. Most of Korea's graphite deposits are located near Kimpo, just south of Seoul, where 4 mines are operated. The graphite industry has been plagued with problems including low grade ores, high tariffs in Japan, and antiquated mining techniques.[9] Small mining operations are being shut down or phased out. Figure 4-27 shows annual graphite production and exports in Korea. 1982 was the worst production year in Korea's history with total production only 21,000 tons because of the worldwide recession depressing prices and demand for graphite. Despite erratic graphite export patterns in

South Korea, the average exports of natural graphite from Korea has been 46,000 tons per year for the last 20 years. Korea's natural graphite export market in 1981 was Japan, Taiwan, and Indonesia.[21]

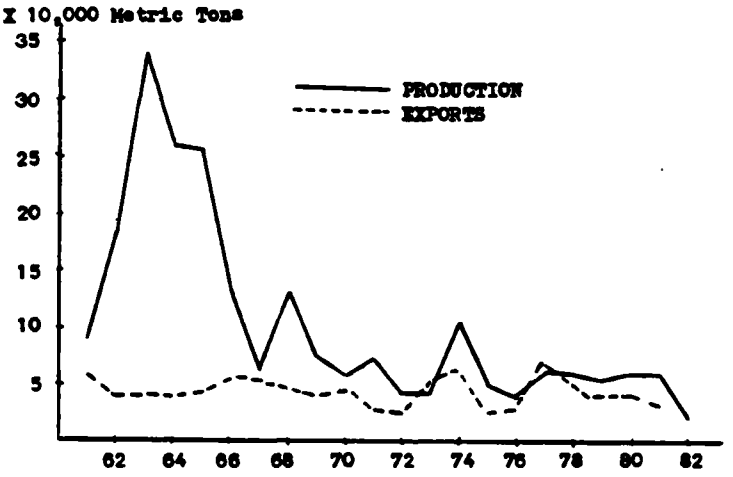


Figure 4-27: Annual Production and Exports of Graphite in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

LIME AND LIMESTONE

Limestone formations are widespread throughout the Korean peninsula in the Great Limestone Series of the Ordovician Age. Consequently, a very thick layer of limestone-rich sedimentary rock extends from the north end almost to the south end of the Republic of Korea. With the exception of 1972, the Republic of Korea has been able to produce enough lime and limestone to meet domestic needs in the steel industry, cement industry, and agricultural sector. Additionally, from 1972 to 1978, exports of small amounts have been reported. Production of limestone virtually ceased in 1969, and thereafter, all lime produced has been in the form of slaked lime, or powdered lime,

used chiefly in cements, mortars, and fertilizers.[9] Annual production of lime and limestone in Korea is shown in Figure 4-28.

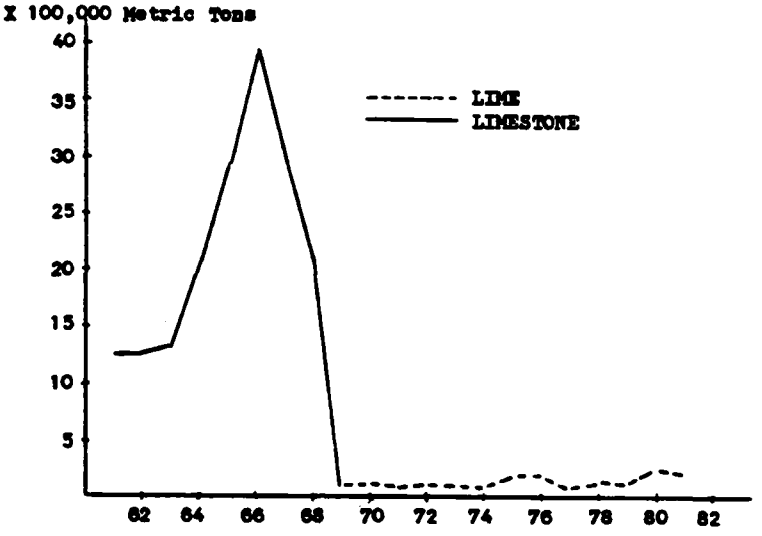


Figure 4-28: Annual Production of Lime and Limestone in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

CLAYS

In the past 10 years, Korea has become a significant world producer of kaolin clay for use in manufacturing Portland cement, ceramics, and china.[9] Beginning in 1975, average annual production of clay in Korea has been over 525,000 tons, with a record production in 1979 and 1981 at 698,000 tons and 694,000 tons, respectively. Figure 4-29 shows annual clay production, imports, and exports in South Korea. Korea has reversed its clay import and export relationships since becoming a world producer. South Korea exports crude clay to Japan and other Asian countries, but finished clay products are mainly shipped to the United States, West Germany, and other countries.

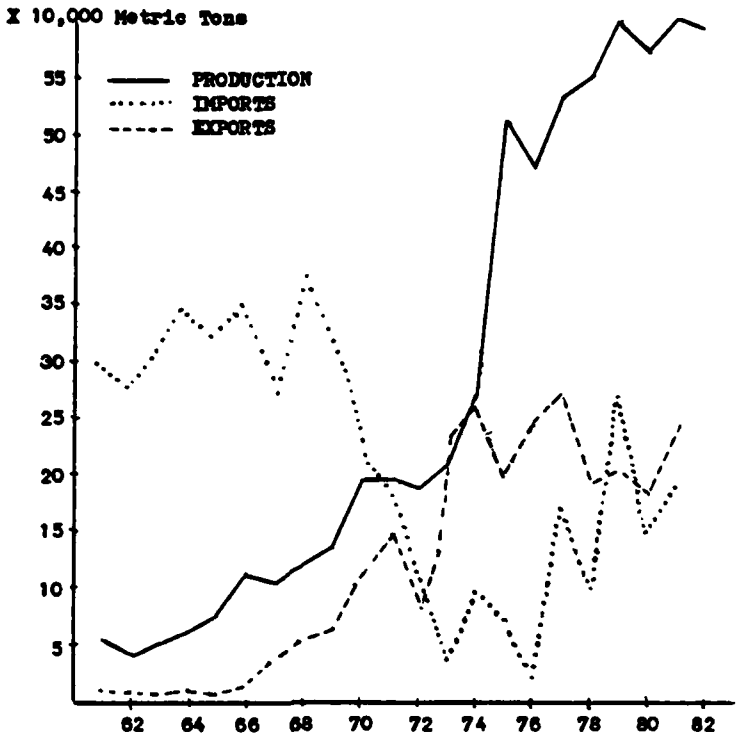


Figure 4-29: Annual Production, Imports, and Exports of Clay and Clay Products in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

FERTILIZER

Korea has traditionally been highly dependent upon fertilizer imports, with virtually no domestic production until 1972. The traditional method of agriculture fertilization in Korea has been manual distribution of human and animal wastes and, in some cases, this practice still continues.[20] Fertilizer is imported primarily from Canada, Belgium, and other Asian countries, with Canada supplying over 91 percent as potassic fertilizer. Production and exports of fertilizer in Korea began in 1972, and has received much emphasis from the Korean Government. Total capacity in 1982 was about 3 million tons

per year, but the industry has been financially weakened by high production costs and sluggish export markets.[21] All fertilizer raw materials are imported - phosphate rock, potash, and sulfur.[9] As a result, the Government Economic Planning Board has decided to reduce total output capacity to 2.17 million tons by 1985.[21] Figure 4-30 shows production, imports, and exports of fertilizer in Korea.

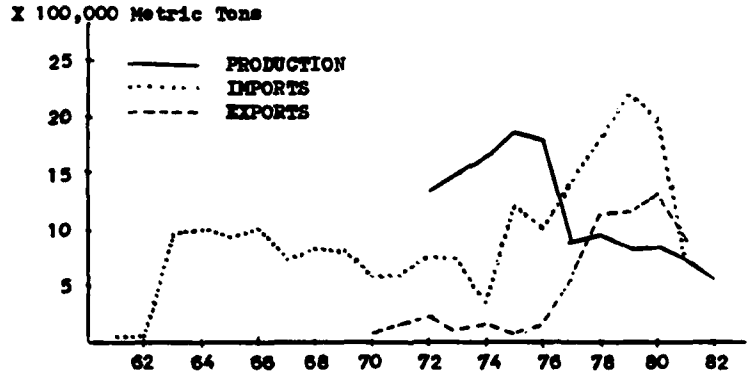


Figure 4-30: Annual Production, Imports, and Exports of Fertilizer (All Types) in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

FELDSPAR AND FLUORSPAR

South Korea has consistently been a significant producer and exporter of feldspar and fluorspar, producing and exporting between 30 and 60 thousand tons each year. Recently, Korea has increased production to an average of 70 thousand tons per year, but is consuming nearly all of this production in the ceramics and glass industry, which has also become important in Korea, whereas exports used to be shipped to other Asian countries for making glass and ceramics.[9] Annual

production and exports of feldspar and fluorspar in Korea are shown in Figure 4-31.

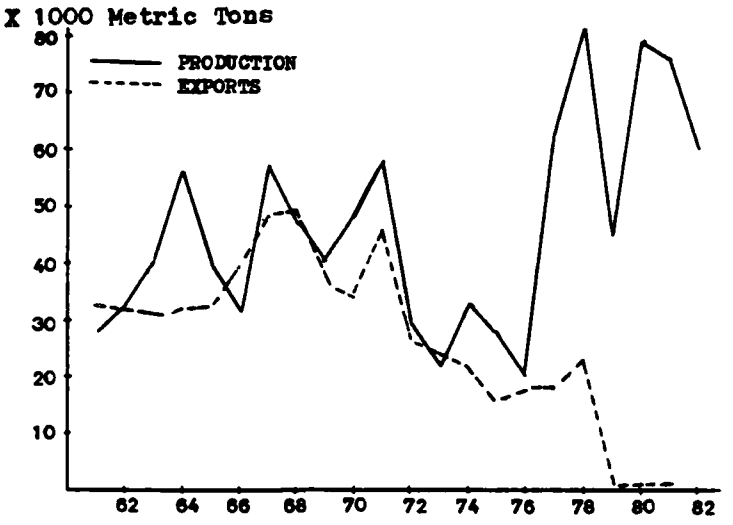


Figure 4-31: Annual Production and Exports of Feldspar and Fluorspar in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

CEMENT

South Korea has, in the past 15 years, become a significant producer and exporter of cement, showing rapid, steady growth in both areas since 1968. In the early 1960's, the booming building industry produced shortages of cement, tripling the price almost overnight.[34] Determined not to allow this to happen again, the government has relentlessly pursued a program of expansion in the cement industry for nearly 20 years.[9] The results of this program has allowed cement exports to soar rapidly to over 6.6 million tons by 1981, but despite increasing exports, in 1981, over 7 million tons of cement were imported from Japan due to energy problems within the cement industry.[21] The record production of 17,887,000 tons in 1982

represents only 65 percent of total capacity and does not meet the government's goal to be able to produce 30 million tons of cement per year by 1986.[28] Korea's cement industry's price competitiveness has been hampered by high operating costs, primarily by the high cost of fuel and electricity.[28] To counter this problem, the industry has begun to convert cement plants from oil to coal-fired kilns. By the end of 1982, nearly 87 percent of the cement plants were converted. To complicate existing problems for the cement industry, traditional export markets for Korean cement, such as Indonesia and Thailand, are developing their own cement industries. To overcome all of these financially devastating problems, the cement industry in Korea is depending on increased activity in domestic and foreign construction by Korean firms.[28] Figure 4-32 shows annual production, imports, and exports of cement in Korea.

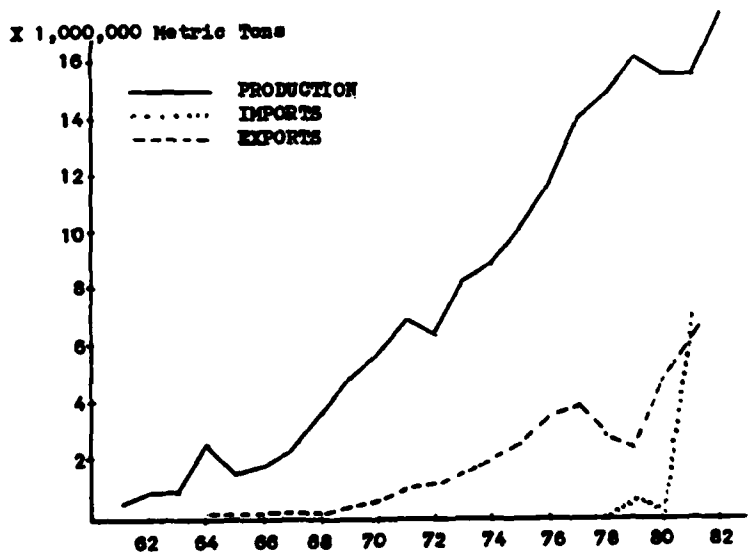


Figure 4-32: Annual Production, Imports, and Exports of Cement in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

TALC

There are over 51 talc deposits in Korea. Talc occurs in dolomite country rock interbedded between limestone, marble, and gneiss, and also in serpentine country rocks that have been invaded by ultrabasic dikes. Mining for talc is done in open pit mines, and is exclusively in these alteration zones.[6] In world terms, South Korea is a significant producer of talc, producing nearly 800,000 metric tons per year, after steady growth since 1965. This trend is likely to continue, despite decreased production in the beginning of the 1980's, because Cyprus Mining Co. and Ilshin Industry Co. Ltd. have recently entered into a joint venture agreement to develop a large talc deposit recently discovered in Chungchong-Namdo Province.[28] Figure 4-33 shows annual production and exports of talc in Korea.

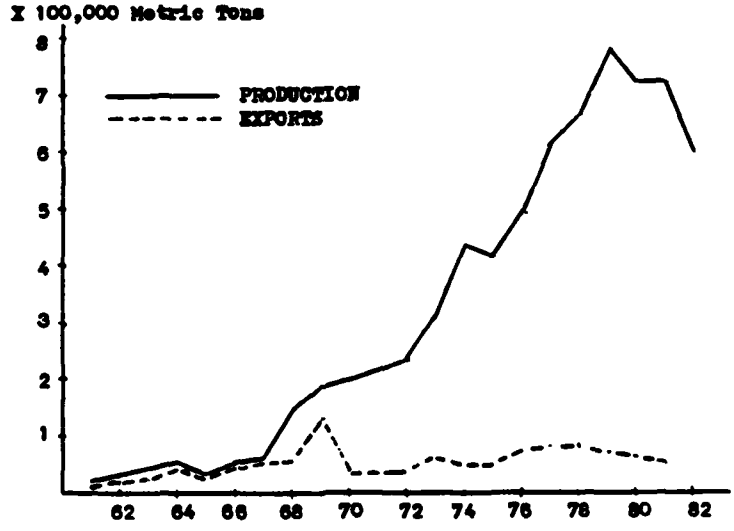


Figure 4-33: Annual Production and Exports of Talc in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

SALT

South Korea produces salt by evaporating seawater in large quantities, averaging over 600,000 tons per year, with production peaking in 1982 at 864,000 tons, but the level of domestic production has not increased significantly in almost 20 years.[9] As a result, and compounded by South Korea's rapid population and industrial growth, over half of domestic consumption is satisfied with imports. Figure 4-34 shows annual production, imports, and exports of salt in Korea.

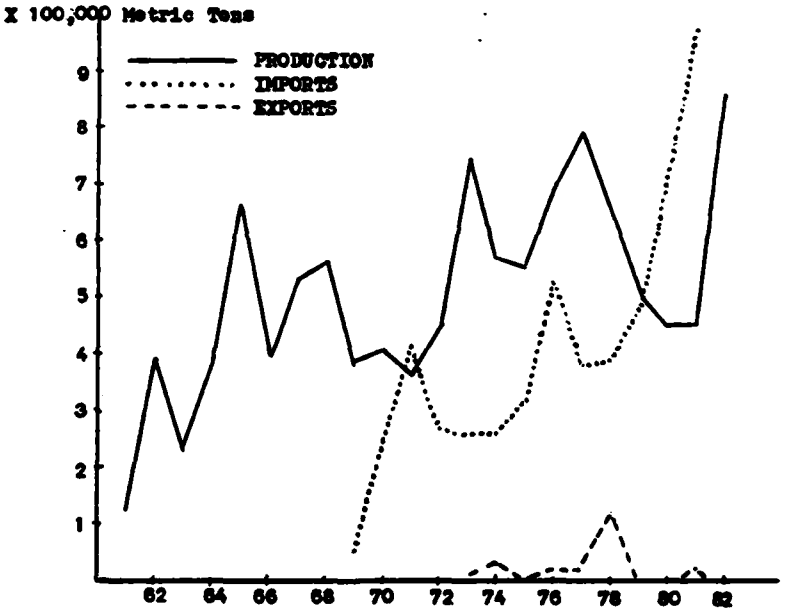


Figure 4-34: Annual Production, Imports, and Exports of Salt in the Republic of Korea, 1961-1982. Source: Minerals Yearbook, U. S. Bureau of Mines.

GYPSUM

South Korea does not report gypsum production in its mineral statistics and has imported only small amounts each year for over 20 years. Despite tremendous activity in the

construction sector, the country started exporting gypsum and plaster in 1970, indicating that domestic production exceeds demand. Figure 4-35 shows annual imports and exports of gypsum in Korea.

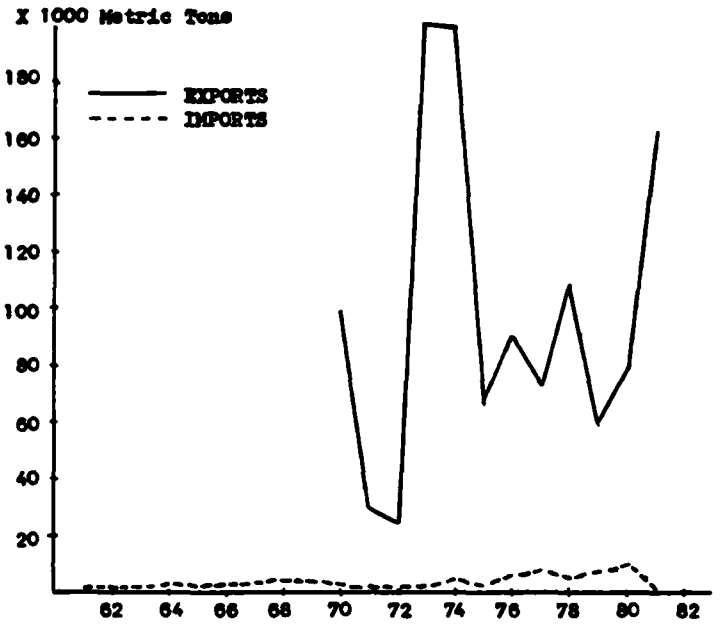


Figure 4-35: Annual Imports and Exports of Gypsum in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

SULFUR

Although sulfur production in Korea began in 1974 by processing pyrite, the country remains 75 percent import-dependent for sulfur supplies. The bulk of sulfur consumption is in the fertilizer industry.[7] Figure 4-36 shows annual production and imports of sulfur in Korea.

SILICA SAND AND STONE

South Korea has greatly increased domestic production of silica sand and stone to support its glass and ceramics

industries. With tremendous resources of quartzite, this commodity, although of relatively low value per unit of volume, could have important economic significance, particularly if ceramics is used to replace steel in selected applications. Research, development, and testing in this area is being done in Japan. Figure 4-37 shows production of silica from 1961-1982. South Korea is presently a modest exporter of silica, all destined to Japan.

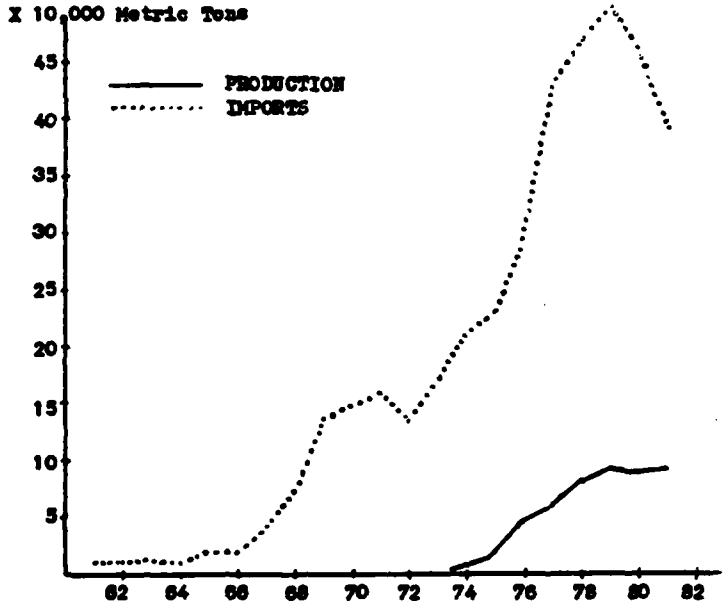


Figure 4-36: Annual Production and Imports of Sulfur in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

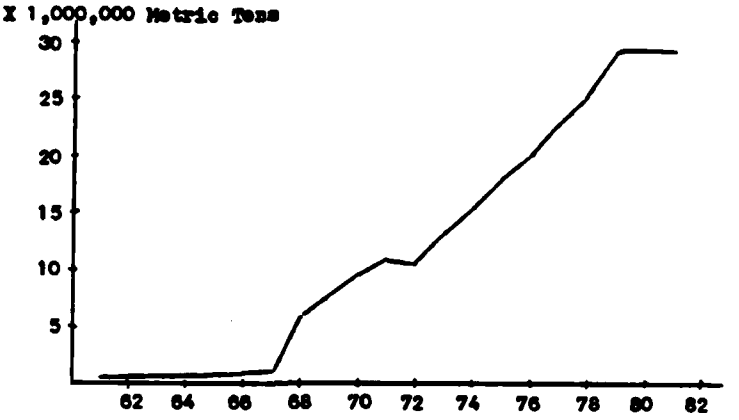


Figure 4-37: Annual Production of Silica Sand and Stone in the Republic of Korea, 1961-1982.
Source: Minerals Yearbook, U. S. Bureau of Mines.

GOVERNMENT POLICY STRATEGIES

The South Korean Government has had an extremely active role in developing the economy of the country, leading the developmental push by issuing goals, guidelines, directives, and giving preferences to certain enterprises. However, the governmental actions have not always been completely beneficial to the country as a whole, and as a result, major strategies have been changed several times. These policy changes were caused by problems such as excessive protectionism policies, giving the Korean trade partners trade deficits with Korea, eventually causing a decline in exports. Another problem was that the government placed too much emphasis on heavy and chemical industries, making Korea depend too heavily on a narrow industrial sector for economic stability.[5]

In the early 1960's, most of the larger industries in South Korea were owned by the government. Government programs

promoted growth in electrical power, coal mining, transportation, communications, fertilizer and cement production, oil refinery capacity, steel mills, and iron ore and tungsten mining.[5] To a large extent, these goals are also the goals of the present government. Beginning in the mid-1960's, the Korean economy had depleted available capital, and foreign investments were encouraged for the first time. Most joint ventures were with the United States and Japanese firms.[5] By 1970, all government-established economic development objectives, from the second five-year plan were achieved.[35] Since then, the government has shifted its emphasis to dealing with energy needs, inflation, and import/export management.[5] Some government-owned corporations have been transferred to the private sector, but many are still owned by the government.

Current government projects include a second integrated steel mill, a third petrochemical complex, pulp and paper plants, tidal water power generation facilities, and nuclear power plants. This a major switch from past strategies which pursued economic growth with emphasis on the heavy and chemical industries. Over $168 billion of investments are planned over the next 5 years in textiles, shipyards, shipping, shipbuilding, and oil refining and storage facilities.[36]

In less than 30 years, South Korea has developed into a fierce international competitor in textiles, steel, and shipbuilding; all energy and raw material intensive industries. Oil imports and raw materials imports have led to persistent trade deficits, and the government continues to have a major

problem in this area. South Korea's trade deficit was $4.79 billion in 1980.[37] Government actions to open trade with other countries and to reduce trade barriers reduced this deficit to $2.65 billion in 1982 and $1.62 billion in 1983.[38] The Korean Government was able to do this by promoting exports and establishing more attractive incentives for foreign investors to ease inflation because of a shortage of money. South Korea has taken several steps to expand its export market. Firstly, Korea abandoned its strict protectionist policy and removed many import restrictions. Allocation of resources used to be based on government priorities, with import/export restrictions, prohibitive tariffs, and institutional entry barriers. These strategies are no longer appropriate.[39] Secondly, the quantitative import restriction on manufacturing machinery was eliminated. This restriction has been responsible for Korea's inferior product quality.[39] Thirdly, South Korea is trying to reduce government intervention in private industries. The Korean Government changed banking policies from lending to government-favored projects to independent credit decisions by bank officials. Investment is now encouraged in smaller high-technology firms instead of huge industrial complexes, and the economy has been opened to foreign imports and competition.[40] This action should have been taken sooner; South Korea's largest foreign investor, Dow Chemical Corporation of the United States, is leaving Korea because of government bureaucracy, even though things have begun to

improve, and warns other companies to think twice before investing in South Korea.[40]

The Korean Government has had to adapt to a changing world situation, or face economic disaster. Ahead, it will be difficult to catch up with more industrialized countries with more sophisticated industrial sectors, such as electronics, especially with the huge external national debt, potentially restricting Korea's source of capital. Behind, other developing countries are moving in the same direction South Korea has, creating competition. In the past, South Korea has stuck to the Japanese model, setting targets and restricting trade to protect infant industries until they could compete and win, but, Korea's domestic demand is no match for Japan's, and the international climate is less tolerant of the protectionist actions that Japan used. Korea also has to face high oil import prices that Japan did not have to contend with during its industrialization.[41]

The present Korean Government has two goals; first, to stabilize prices, curbing the country's high inflation, and second, to make South Korean industry more competitive on the world market.[41] To accomplish these goals, the government's import policy has been changed to importing products that domestic companies can compete against, and products that its companies will never be able to manufacture.[40] The government sees companies with less than 300 employees being more innovative and the ones that will be the future economic strength of high technology industries.[41] To enhance the growth of these

smaller companies, the government offers special incentives for research and development, such as accelerated depreciation, tax breaks on earnings from high technology properties, duty exemptions on imports used for research and special access to bank loans for research purposes.[41]

Among the long-term social goals of the Korean Government are telecommunications projects, sewage treatment systems, airport expansions, hosting the 1986 Asian Games, and hosting the 1988 World Summer Olympics.

RELATIONS WITH THE UNITED STATES

The United States and the Republic of Korea are currently enjoying very good economical and political relations, but these relations were markedly weaker during the previous U. S. Administration when President Carter was moving toward total withdrawal of U. S. troops from the peninsular country, a move that was stopped by President Reagan.[43] In response to the improved relations with the United States, many trade restrictions have been lifted. The U. S. removed import restrictions on Korean electronic equipment and footwear. In turn, the South Korean Government lifted import barriers on 33 U. S. products, including general purpose computers, carpets, large-sized refrigerators, and fresh and processed fruits. A climate for more joint U. S. - Korean ventures is being established.[43]

In 1982, the United States took over Japan's position of being the biggest trader with South Korea. Exports to South Korea were $5.53 billion and imports from Korea were $5.64

billion.[43]

RELATIONS WITH JAPAN

South Korea's shipbuilding industry is nearly as large as Japan's, and Korea is underselling Japanese steel by a wide margin, even to Japanese firms. Additionally, Korea is challenging Japan's consumer electronics and semi-conductors industries.[2] South Korea is following in Japan's footsteps very closely, but has a number of dissadvantages: (1) Japan's economy is 14 times as large as South Korea's; (2) average per capita income in Korea is $2000 compared to $9500 in Japan; (3) Korea's debt problem makes the country fourth most indebted developing country, behind Brazil, Mexico, and Argentina; (4) Korea's defense budget is 6 percent of the gross national product, the same as the United States.[2] Korea and Japan have similarities; both have a disciplined work force, and both lack raw materials, but Koreans are more willing to work to excell, and Korea's managers are better educated.[2]

At the present time, in an effort to control Korea's competitiveness, Japan is not helping South Korea with technical advancement, and to counteract the low wages in Korea, Japan is beginning to work with robots.[2] Korea has taken the black and white television manufacturing industry from Japan, and is now the largest producer in the world, and presently video cassette recorders, personal computers, stereos, and colored televisions are being produced in increasing quantities in Korea.[2] In terms of mineral trade, Japan and Korea work

closer together than in other sectors. Japan is a major trading partner and processes most of the minerals that Korea cannot process and refine domestically. Compared to Japan's total mineral trade, the quantity of minerals produced and traded in Korea is very insignificant, so, for that reason, Korea and Japan pose no threat to each other in the mineral industry. South Korea is following so closely in Japan's footsteps that if Japan takes a wrong step, Korea will follow. The difference between the two countries is that Japan would only falter, Korea would probably fall.[2]

RELATIONS WITH CHINA

South Korea and the People's Republic of China presently have no diplomatic relations, mostly because of the close ties China has with North Korea. Consequently, the Chinese and the South Korean Governments have very few dealings with one another because such dealings would imply that the Chinese Government recognizes South Korea as a legitimate government. Because of these political problems, trade between South Korea and China is quite insignificant.[47]

TAXES IN THE REPUBLIC OF KOREA

In addition to trade deficits, Korea has been plagued with government budget deficits as well. In 1983, the national budget was $14.1 billion, with a budget deficit of $470 million.[44] The previous year's government deficit was $1.81 billion.[45] One reason for this deficit is the fact that South Korea supports the fifth largest military force in the world,

totalling 600,000 active duty personnel.[1] The budget deficits have been cut due to checks on spending and increases in taxes and other revenues. The government generates a substantial amount of revenue by owning monopolies in several industries.

The corporate income tax rate, in 1983, amounted to 30 percent of profit, down from 33 percent in 1982.[46] These taxes were reduced to be competitive with rival countries, but are still higher than promised by the present government. The individual income tax rate in 1982 was 19.5 percent plus education taxes, defense taxes, and infrastructure taxes levied on interest income, liquor, cigarettes, and income from banks and insurance companies.[45] Additionally, large corporations that are not listed with the Korean Stock Exchange are taxed heavily, through reduced exemptions, to encourage them to go public.[45]

POLICY ANALYSIS CONSIDERATIONS

Although the United States is a significant trader with the Republic of Korea, the volume of trade with Korea is not particularly significant to the United States. This is because of the disparity in size between the two countries; one is a superpower, and the other is only a small, developing country. Korean industry has been concentrated on the textile industry, steelmaking, and petrochemicals. With cheap labor, Korean production costs have been lower than those in the United States, making Korean products highly competitive on the U. S. market.

In terms of a source of mineral resources, Korea is not a significant source for the United States, unable to compete

with the economies of scale in major producing countries. However, less than one-third of South Korea has been explored for mineral resources, and the South Korean Government is presently concentrating exploration efforts to locate more reserves.[22] Success in this exploration could make Korea a significant source of tungsten, graphite, fluorite, gold, and silver.

In terms of manufacturing, South Korea is an excellent country for U. S. corporations to invest in foreign joint ventures. The work force is well-educated, disciplined, and cheap. The political climate in Korea is strong and there is no history of expropriation or nationalization disputes.

A major policy consideration between the United States and South Korea is national defense of the Korean peninsula. South Korea has a well-developed industrial base and port system. Should this country fall into Communist hands, numerous political advantages currently enjoyed by the United States and its Asian allies would be lost. North Korea desparately needs South Korea's steel refinery capacity to process iron ore located in the southwest. By possessing South Korea, North Korea would have free use of many new ports to transport raw materials from the north to the industrial centers, and South Korea's freeway system would greatly enhance the mobility of the North Koreans. Geographically, South Korea represents a barrier between the Communist world and Japan, the Philippines, and the rest of Asia. Possession of South Korea would give the Communists the capability of launching land-based fighters against Japan who has been restrained from building military

strength until very recently.

Politically speaking, relations with South Korea are of little or no consequence. The Korean people are very pro-American.[20] The important aspect of U. S. - Korean policy is economical. If the United States reduces its trade with Korea, the Korean economy would suffer drastically and Korea's national defense is dependent upon a stable economy.

REFERENCES

1 Frederica M. Bunge, South Korea: A Country Study (Washington, D. C.: U. S. Government Printing Office, 1982).

2 Lee Smith, "Korea's Challenge to Japan," Fortune, February 6, 1984.

3 Nena Vreeland, et al., Area Handbook of South Korea, 2d Ed. (Washington, D. C.: U. S. Government Printing Office, 1982).

4 Korean Overseas Information Service, Ministry of Culture and Information, A Handbook of Korea (Seoul: Sejongno One Publishers, January 1982).

5 Jeong-Su Kye and Jeong-Man Jee, "Report on the Fluorite Deposits of South Korea," Geological Survey of Korea (Seoul: Kungnip Chijil Chasaso, No. 13, 1971).

6 Kyu-Bong Kim, "Talc Deposits of South Korea," Geological Survey of Korea (Seoul: Kungnip Chijil Chasaso, No. 14, 1971).

7 Ho-Kun Cheuong, "Symtomatical Plant Survey on Ulchin Lead-Zinc Mine Area," Geological Survey of Korea (Seoul: Kungnip Chijil Chasaso, No. 15, 1972).

8 Soo-Jin Kim and Gil-Seung Kim, "Manganese Deposits of South Korea," Geological Survey of Korea (Seoul: Kungnip Chijil Chasaso, No. 13, 1971).

9 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1961-1982).

10 Jin-Seob Cha, An Assessment of the Role of Coal in the Long-Term Energy Plan for Korea (Monterey: U. S. Naval Post Graduate School, March 1972).

11 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1980).

12 Anon., "Seoul 3-Year Plan Maps GNP Growth of 7.5 Percent, Debt Curb," Wall Street Journal, December 23, 1983, Sec. 2, p. 12e.

13 Cheng-Hye Cheah, "South Korea Seeking Loan of $500 Million," Wall Street Journal, September 23, 1983, Sec. 2, p. 34e.

14 Dennis W. Holden, "Korea Debt Picture Appears to be Sound," United States Banker, October 1983.

15 Anon., "South Korea Outlines 5-Year $8 Billion Plan for Industrial Growth," Wall Street Journal, September 8, 1981, Sec. 2, p. 39e.

16 Anon., "South Korea Introduces Austere 1984 Budget," Wall Street Journal, September 23, 1983, Sec. 2, p. 34e.

17 Anon., "South Korea Finds Deposit of High-Grade Uranium," Wall Street Journal, May 9, 1980, Sec. 2, p. 34e.

18 Anon., "South Korea to Build a Nuclear Fuel Plant with Foreign Partners," Wall Street Journal, April 30, 1982, Sec. 2, p. 34e.

19 Frederica M. Bunge, South Korea: A Country Study (Washington, D. C.: U. S. Government Printing Office, 1982) p. 134-141.

20 Based on personal experience while serving as Petroleum Officer, United States Army, Tongduchon, Korea, 1979-1980.

21 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1982).

22 Anon., "What's Going on in World Mining," World Mining, 1973-1984.

23 Frederica M. Bunge, South Korea: A Country Study (Washington, D. C.: U. S. Government Printing Office, 1982) p. 149-158.

24 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1967).

25 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1972).

26 Marcia A. Parker, "South Korea Stepping up Offshore Exploration," Oil and Gas Journal, September 26, 1983.

27 Anon., "Indonesia - Korea Sign LNG Accord," Oil Daily, April 15, 1983.

28 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1981).

29 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1978-79).

30 Anon., "Korea Steel Exports May be Injuring U. S. Firms, I.T.C. Rules," Wall Street Journal, December 8, 1983, Sec. 2, p. 22e.

31 Anon., "Worldwide Survey," World Mining, 1973-1984.

32 Anon., "Korean Uncertainties Stall Australian Venture," Wall Street Journal, October 12, 1983, Sec. 2, p. 41e.

33 Kyu-Bong Kim and Yong-Deock Yoon, "Geology and Ore Deposits of the Ulchin Area," Geological Survey of Korea (Seoul: Kungnip Chijil Chasaso, 1972).

34 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1963).

35 U. S. Department of the Interior, Bureau of Mines, "The Mineral Industry of the Republic of Korea," by Edmond Chin, Minerals Yearbook (Washington, D. C.: U. S. Government Printing Office, 1970).

36 Norman Thorpe, "South Korea's Economic Programs Reduces Expansion in Several Major Industries," Wall Street Journal, July 24, 1981, Sec. 2, p. 24e.

37 Anon., "South Korea Trade Deficit Totalled $4.79 Billion in 1980," Wall Street Journal, February 4, 1981, Sec. 2, p. 31e.

38 Anon., "Korea Deficit Narrowed to $1.62 Billion in 1983," Wall Street Journal, January 17, 1984, Sec. 2, p. 35e.

39 Hahn-Choon Lee, "Korea: Land of Surprising Export Growth," American Import-Export Management, December 1983, p. 30-34.

40 James R. Schiffman and E. S. Browning, "South Korea Tries to Cut Economic Role of Government, but Bureaucracy Resists," Wall Street Journal, September 18, 1984, Sec.2, p. 28e.

41 David Stewart-Patterson, "South Korea Faces Tough Choices on Policy," The Journal of Commerce, January 18, 1984.

42 Daniel Duvall and Deborah Lamb, "Korea: Economy Set for Recovery; U. S. Becomes Top Supplier," Business America, February 21, 1983, p. 19.

43 Urban C. Lehner, "Koreans Finding a World of Difference Between Carter and Reagan Policies," Wall Street Journal, December 15, 1981, Sec. 2, p. 34e.

44 Anon., "Revised Budget Bill for South Korea Cuts Promised Tax Relief," Wall Street Journal, December 1, 1982, Sec. 2, p. 30e.

45 Anon., "South Korea Introduces Austere 1984 Budget," Wall Street Journal, September 23, 1983, Sec. 2, p. 34e.

46 Chong-Shik Chung and Kwang-Gil Kay, Korea Annual 1983 (Seoul: Yonhap News Agency, Kwangshamoon, July 1983).

47 Anon., "South Korea Hits a Snag in Relations with China," Wall Street Journal, May 10, 1983, Sec. 2, p. 40e.

END

DTIC

10—86